POWER

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Benjamin Franklin

TWO HUNDRED AND TWENTY-FOUR years ago, on the 17th of January, 1706, there was born at Boston one of the outstanding figures of the formative period of civilized America.

The youngest boy of a family of thirteen children, the son of an immigrant of limited means, he was taken out of school at ten years of age to help his father boil soap and make candles.

I wonder what some of the self-excusing failures who "never had half a chance" would think of his as a start.

What were the traits and the training that enabled Ben Franklin to lift himself out of the candle shop to shine in the highest circles of his time and leave a name that will be spoken among the first in any enumeration of great Americans?

Was it because he had read Plutarch, Bunyan and Locke and committed whole pages of *The Spectator* to memory at fifteen that he was able to impress himself upon and make an interested friend of some big man every time he went out of town?

Or was it the ambition, the self-confidence, the reaching outward and upward which impelled and heartened him to approach such men that led him to seek the best attainable through reading and study?

Some boys would have kept on boiling soap and cutting candle wicks. Ben got himself apprenticed to his brother James, who was just starting out as a printer and publisher.

Here was an opportunity for self-expression that Benjamin did not delay about improving. And the apprentice's writings took so well as to put his master brother's nose out of joint.

What did young Benjamin have that Big Brother James lacked? Why did Ben soar while his master is known to history only as his brother?

I enjoy Benjamin's tact when instead of cussing out a member of the Assembly who voted against his appointment and accepting him as an enemy or opponent he borrowed a book of him and made him a friend for life.

His identification of lightning with static electricity, while of less moment than Faraday's discovery of the generation of electricity by the passage of a conductor across a magnetic field, was more spectacular and associated Franklin's name most prominently with electricity in the public mind for many years.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

"Go Thou And Do Likewise"

IT IS ONE THING to talk about "reducing the cost of power." It is another to get it done.

Many industrial power plants should take this to heart. Among the public utilities it is as inevitable as the yearly budget that large sums shall be spent for new devices and improvements of proved value. This year the utilities will spend 910 million dollars upon plants and equipment for power generation and distribution. A good proportion of this will go into repairs, maintenance, clean-up, general betterments, improvement, re-equipment, replacement; that is, modernization.

Why is this? Because the utilities expect to stay in business, and they recognize that to give reliable service and make kilowatt-hours at a profit their equipment must keep pace with the developments of the day. It is money in their pockets.

Numbers of industrial executives are missing this same opportunity to make money by blindly passing the power house door. If they won't see, or are not able to analyze, these possibilities, it will pay them to employ consultants.

Aside from the statement of the National Business Survey Conference that our country's prosperity is closely related to this activity, the resulting lower cost of power should alone be sufficient reason to do something.

In short, industrial executives need look no further than to reducing the cost of power for sufficient reason to modernize their old plants.

What the public utilities have proved to be good business is good also for the industrial power plant.

Accurate Records Promote Efficiency

ACCURATE records are essential to the success of any business. This applies also to the power plant. Before a plant can be operated intelligently records of its performance must be available and they must be carefully analyzed. Invariably, those plants in which proper records are kept and used show the lowest operating cost.

Meters are now generally considered an essential part of power equipment. But they must be used intelligently. The first requisite is to select and install the meters so that a comprehensive record of the factors influencing operation may be obtained. The second requirement is that the readings be assembled into records showing the plant performance and that a careful study be made of them.

Many meter installations are not selected according to suitability for keeping records. There is little use of measuring the coal burned in the furnace without also keeping corresponding records of the water supplied to, and the steam produced by, the boiler. When the input and the output are known, the performance can be determined. In conjunction with the input and output records, instruments giving important details of operation are required for a complete analysis of performance. If equipment is falling below standard, this fact will become known and the cause will be readily determined. Without such records, the attendants work in the dark, and those responsible for the plant's operation have no definite means of checking the operators.

Records of equipment performance also have an important place in maintenance work. Costly and unexpected shutdowns are frequently avoided through warnings given by abnormal changes in meter readings. Then again, the study of load characteristics may lead to changes in process operations that will produce large savings.

Just as in any business, accurate plant operation records will remove uncertainty and establish efficiency and reliability.

"Unknown Soldiers" Of Engineering

GREAT names catch the eye and the imagination. The single figure of Napoleon gets more attention than all the countless thousands who suffered and died to make his dreams come true.

It is the same in the field of science and engineering. Edison and Bell, with their crude prototypes of today's electric light and telephone, bulk greater in the popular imagination than the host of those who have brought these instruments of civilization to their present perfection and distribution.

Only since the World War is the common soldier coming into his own. Symbolized as the "unknown soldier," he receives the homage of kings, presidents and generals. Is the time not ripe for a similar recognition of the unknown soldier of industry and engineering?

A radio plea for such recognition was made on New Year's Day by A. W. Robertson, Chairman of the Board of Westinghouse Electric & Manufacturing Company. "I think," said Mr. Robertson, "science needs to recognize, in somewhat the same way, the unknown toilers in our laboratories and shops, who, without any special recognition, add item by item to the inventions, until the first

crude expression of an invention becomes the perfect, completed, useful article of every-day life. Without these innumerable contributions of unknown men, not a single modern art would be of much practical value today. In other words, the contributions of the many, unknown though they may be, are more important, in my mind, than the contributions of the few, which are so well known.

"The radio over which you hear my voice was made possible in its perfection by many unknown men. The electric light that you read by was made possible in its present reliable perfection, from power plant to home, by many more unknown thousands. All your household devices are the products of tens of thousands of unknown minds."

This broader appreciation of public service need not dim the light of the great pioneers; as individuals these immortals must continue to stand unique. But greater recognition of those who complete and perfect the work of the pioneer is proper and necessary if we are to see things in true perspective. Nor would the true pioneer begrudge his fellow-workers their share of the glory.

Superheat and Turbine Maintenance

THE degree of superheat maintained at the turbine throttle has a great influence on the cost of turbine maintenance. This fact is not fully realized by all engineers, or better judgment would be shown in selecting the initial steam temperature and in maintaining this temperature in service.

When steam expands through the nozzles and blades of a turbine, heat is transformed into work in that proportion represented by the efficiency of the turbine. Small non-condensing turbines have low efficiency and hence transform little heat into work. Large condensing turbines are now built for high efficiency and thus transform a large portion of the heat available from expansion into work. This withdrawal of heat from the steam during its expansion progressively lowers its total heat content, so that the steam gradually loses its superheat and in the latter stages of the turbine it becomes wet.

The degree of wetness in the low-pressure portion of the turbine depends on the initial steam temperature.

The more the superheat at a given pressure the less is the wetness at exhaust. Also, the more efficient the turbine the greater the heat withdrawal as work and the wetter the steam at exhaust. Hence the damage of wet steam on turbine blading will be more pronounced in the newer and more economical turbines than in older units.

Wet steam in the last rows causes serious blade erosion, which has been pronounced in some impulse turbines due to the high steam and blade speeds employed. Eroded blades diminish the turbine efficiency, increase the risk of accident from breakage and increase the outage periods of the turbine by requiring renewal. In fact, the renewal of the last rows of blades has become standard maintenance procedure at regular periods on many turbines. The high speeds of the low-pressure sections of Parsons turbines will make those sections of blading also subject to rapid erosion if the steam is wet in these stages.

Constant renewals are expensive. How can they be prevented? Advances have been made in developing better blade materials, but erosion-proof blading is not yet available. Possibly some facing material may be developed for this purpose, such as plating by chromium. The initial superheat should be maintained at all loads as high as the turbine will stand. H. L. Guy, well known British engineer, in a recent paper states that experience has indicated that the wetness of the exhaust steam of turbines should be limited between 7 and 10 per cent. Builders in this country prefer to keep below 10 per cent. Many turbines exhaust steam with 12 per cent moisture, which obviously must cause increased erosion.

Another operating difficulty causing increased erosion is the practice of letting the initial superheat decrease with drop in load. It cannot be prevented in some cases. In others a study of boiler operation may remedy the trouble. Sometimes better pipe insulation is needed.

The relation of initial superheat to the cost of blade replacement is thus a subject deserving better consideration and further thought on the part of engineers in the interests of lower operating and maintenance costs.

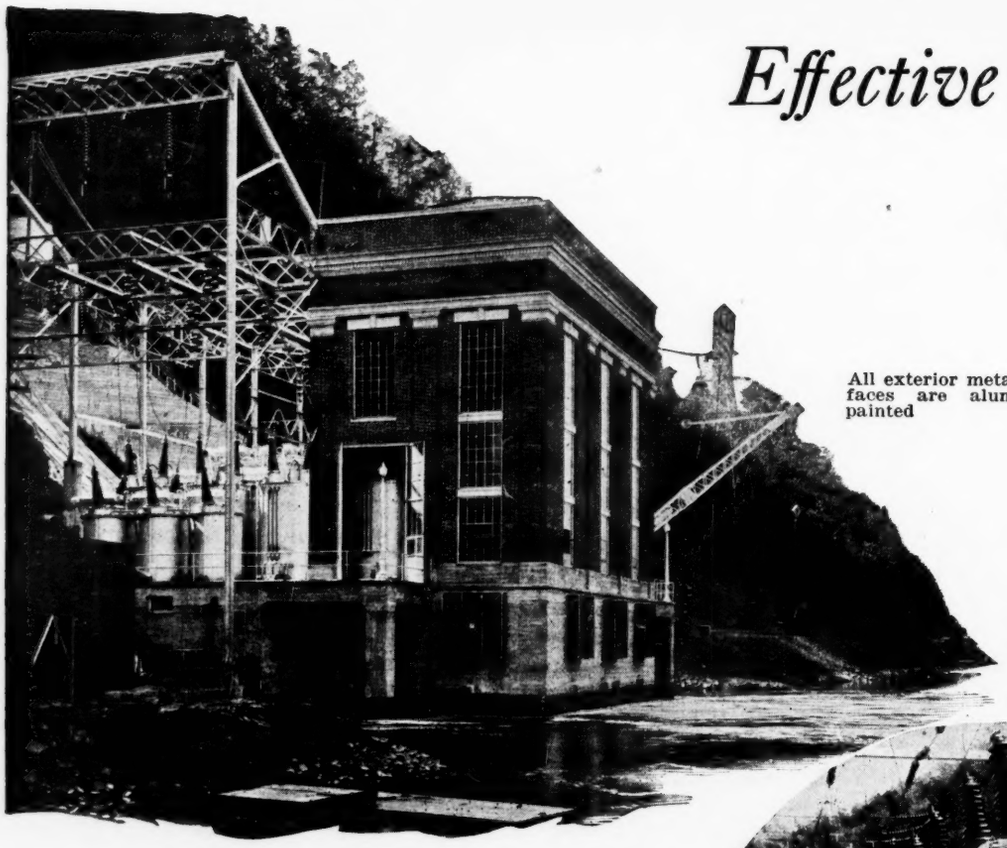
Research Will Pay In 1930

"THE pragmatic value of research was graphically indicated by the fact that more than 20 per cent of the total income received was for electrical apparatus which as recently as a decade ago was either unknown or of negligible importance commercially." This quotation, from a General Electric Company statement regarding its 1929 business, shows how the faith of one pioneer in industrial research has been rewarded. Similar illustrations could be drawn from the experience of other corporations.

In the past the great obstacle confronting the proponents of industrial research was the impossibility of stating in advance just what one proposed to discover. Business men were suspicious of such vague aims. Today, however, research has demonstrated its ability to pay its way, although the precise method of that payment cannot be predicted. As a result, research of one sort or another is now part of every well-ordered manufacturing business. More than that, it is a fundamental business activity, one that must be kept healthy at all times. Any attempt to retrench on research now or at any other time would be a fundamental error.

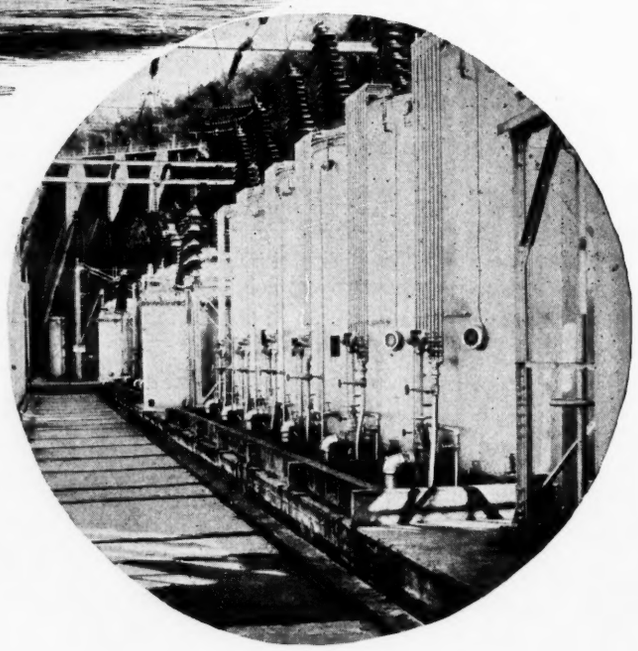
There is little probability that any such false move will be attempted in the larger concerns, where research has been long established, but a word of warning may not be amiss in the case of younger companies, where research may still be classed as a non-essential frill.

Effective Painting In Power



All exterior metal surfaces are aluminum painted

Transformers painted with aluminum seem to run a few degrees cooler in bright sunshine



PAINT has become an effective instrument in the power house. The sole function of preserving the surface of materials from attack has given way, in the modern plant, to an entirely new conception of its utility. The power house has become a livable place. Harmonious and agreeable color has replaced the conventional black. The dark corners are now alive. A train of subsequent improvements has followed in the wake of this renaissance. Leaky pipes have been refitted, blown gaskets have been replaced and oil leaks have been stopped. Color and freshness begets good housekeeping, which spells good operation and efficient maintenance.

Aluminum paint has contributed in large measure to the new order of things in the power plant. The results of a program of painting covering the last six years in connection with hydro-electric plants will be of interest to power plant men generally.

The plants are located in the South, and subject to extreme weather conditions, with a large percentage of sunshine, heavy rainfall and rapid variations in temperature, all of which represents severe service for paint. The outside structures have uniformly been aluminum painted. This applies to handrails of pipe and wood, motor and machinery housings of cast iron and sheet steel, and all fabricated steel structures on the dams, penstocks, gate houses, power plants and substations.

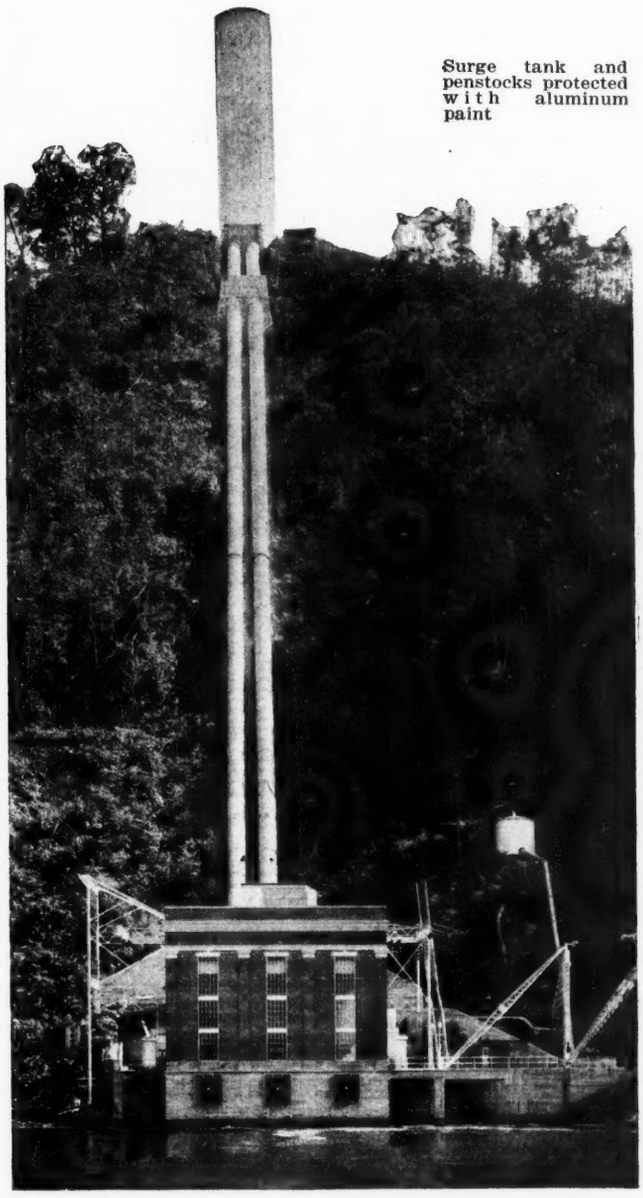
The treatment of the interior of the plants has been given particular study. In general, red quarry tile is used on the floor, which matches the red texture of the brick walls on the interior of the station. The wainscoting and the dado on the concrete columns is brewster green enamel, as likewise are the generators and exposed parts of the waterwheel casings. The interior steel work, including the crane, is coated with aluminum, which blends well with nearly all color combinations. All electrical conduits are aluminum painted. The extensive piping system for oil, water and air is painted with a color code for convenience and safety in operation and maintenance of the plant. How this color code has been applied to the piping in the plants under discussion will be covered in a later number of *Power*.

The walls and ceilings of alcoves, the switch-gear rooms, the control room and the rooms for the auxiliary equipment are finished with aluminum paint. The definite purpose here is one of cleanliness and good illumination. Artificial lighting is seldom necessary during daylight hours. A uniform reflection from the walls and ceiling is obtained without it. The smooth surface of the aluminum paint film does not readily catch dust or spider webs. When the surface is soiled

Improves
EQUIPMENT OPERATION

By J. ELMER HOUSLEY
Plant Superintendent
Tallassee Power Company, Tapoco, N. C.

The results of a hydro-electric power-plant painting program covering six years of severe service. Even though this program has to do with water-power plants, much of the experience is applicable to steam plants. Aluminum paint has been used extensively



Surge tank and penstocks protected with aluminum paint

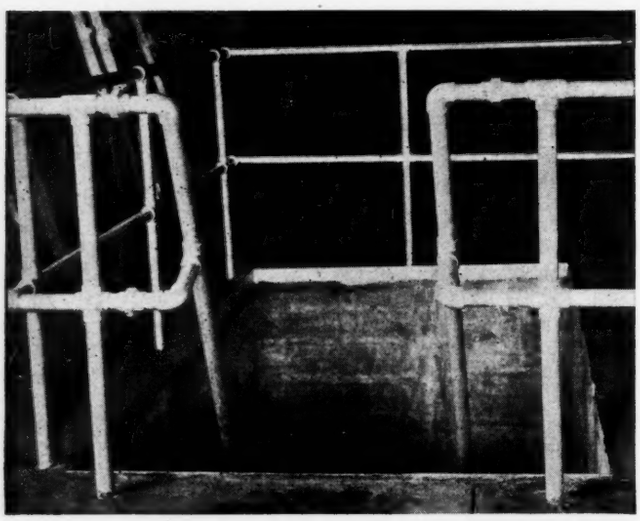
by finger prints or requires cleaning, it may be wiped with a dry dust cloth or washed with water.

Aluminum paint on exteriors that have been in service over six years presents a uniform smooth appearance, with no chipping, flaking or cracking, and retains almost the original silver-gray color. This is a decided advantage in favor of aluminum paint, because repairs and alterations may be necessary or abrasions to the paint film may cause the need of local repainting. This can usually be made by finishing only between the breaks in the outline of surface, such as between two pipe fittings on a handrail. A small patch of new paint on a smooth surface of old paint will show only a slight difference in shade.

Aluminum paint is composed of a vehicle with a metallic flake-like pigment and is essentially different from other paints. Certain characteristics should be kept in mind to insure the easy application and the best service from this paint. The pigment is pure aluminum bronze powder made by stamping sheet aluminum into small thin flakes. This powder is then graded and polished to give it a lustrous and brilliant surface. Low-grade powder containing adulterants, such as mica, should be avoided. The paint is made by simply mixing the powder with the proper oil or a varnish. When applied, the thin flakes align themselves as a film of metallic aluminum, which is termed leafing. This coat of metal is opaque to sunlight and protects the vehicle from injury by the sun's ultra-violet rays. The opaque film is responsible for the hiding qualities of aluminum paint, as one coat will cover even a black surface. The weathering away of the metal film and vehicle is an extremely slow process.

Varnishes are well adapted for application to outdoor structural steel and are extensively used for wood. They are very good for making aluminum paint because of their excellent spreading and covering qualities. Long-oil spar varnishes, in particular, form, with aluminum powder, tough and durable paint films that are almost impervious to moisture and quite resistant under severe atmospheric conditions. A long-oil varnish is one in which the amount of vegetable oil present exceeds the

amount of gum or resin. A varnish of just the proper consistency is suggested by the necessity of eliminating the human element in thinning, which may be carried too far. It is important to use the proper amount of pigment to secure satisfactory results, including an opaque film, good covering and spreading power. The proportion of 2 lb. of powder to each gallon of vehicle should be used. The standard varnished aluminum bronze powder is the grade generally specified for paint.

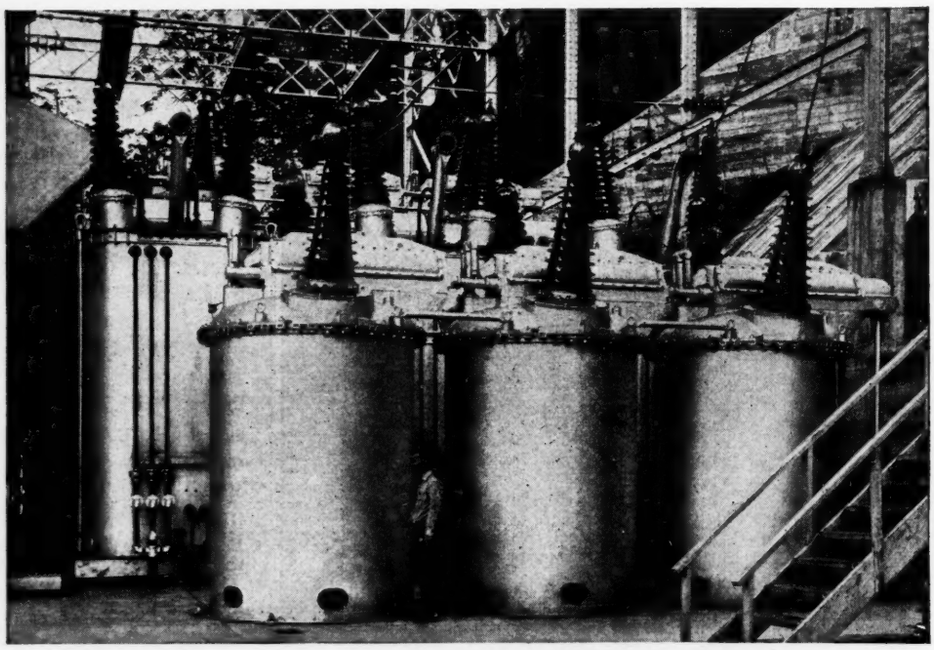


Aluminum paint is easily transported on account of its low weight. It can readily be mixed as needed; so that only enough for one day's use should be mixed at a time, to preserve maximum leafing qualities. The weighed amount of powder should be placed in a suitable container and the measured volume of vehicle then poured over it, while stirring with a paddle. The proportion of 2 lb. of aluminum bronze powder per gallon of vehicle makes a paint containing about 21 per cent of pigment and 79 per cent vehicle. The resulting mixture measures about 1⅛ gallons.

The methods discussed have resulted in uniform satisfaction with the paint during application as well as its appearance after many years' exposure. Most of the paint has been applied by unskilled painters. No trouble was experienced from sags and runs. The paint did not gum and pull under the brush. Resistance to wear and abrasion has been good, and the paint film on the top handrail on much used stairways has lasted two or three years. No weathering effects are noticeable on the six-year old jobs, and apparently the surface will not require attention for some years, as no cracks or blisters have formed.

Preparation of the surface before painting is important. It must be clean, dry and entirely free from grease or oil. Several methods were used, with satisfactory results in each case. Where a sand blast was available, it was applied, and its use is almost a necessity if pitting of the surface has taken place. Painting of old surfaces was started when the first sign of blisters appeared on steel structures. Where the area was not great and fairly smooth, steel scrapers, made from old files, answered the purpose well. Where the paint was not checked badly or rust had not formed under the film, the surface was gone over thoroughly with a wire brush. Lattice steel work was cleaned with a wire brush (but it should not be allowed to get in bad condition or the expense of cleaning and painting is excessive).

Cast-iron surfaces were seldom found to be bad under the paint film. All loose paint and scale were removed, to insure proper adherence of the new paint.



Above — Resistance to wear and abrasion of aluminum paint is good and the paint film on the top handrails of much-used stairways has lasted for two or three years

Left—When painting oil switches and transformers care must be exercised to prevent the paint from getting into the insulating oil and on the insulators

The original lead paint applied at one plant was four years old when repainting with aluminum was first required on exposed locations. After preparation there were always large surfaces where the base metal was exposed. In the case of steel only, all bare spots were primed with a coat of red lead. This acts as a rust inhibitive for steel. The aluminum paint was applied 48 hr. after the red lead, and a second coat of aluminum followed 48 hr. after the first. No painting was attempted on wet days or when the temperature was below 35 deg. F. On very cold days a small amount of mineral spirits was added to the vehicle before mixing, to

improve its spreading qualities. Thinning should be avoided if possible, and when necessary must be done before mixing, so as not to disturb the proper proportions of powder and vehicle.

Good adherence of the paint to galvanized iron on transmission line structures and corrugated buildings was obtained where the surface had been exposed to the weather for a few months before painting.

Over 100 transformers in sizes ranging from 5 to 14,000 kva. were painted with aluminum. The objective was the preservation of the tanks. It was found that the self-cooled transformers seem to run a few degrees cooler under bright sunshine with aluminum paint, but at other times there seems to be no measureable difference.

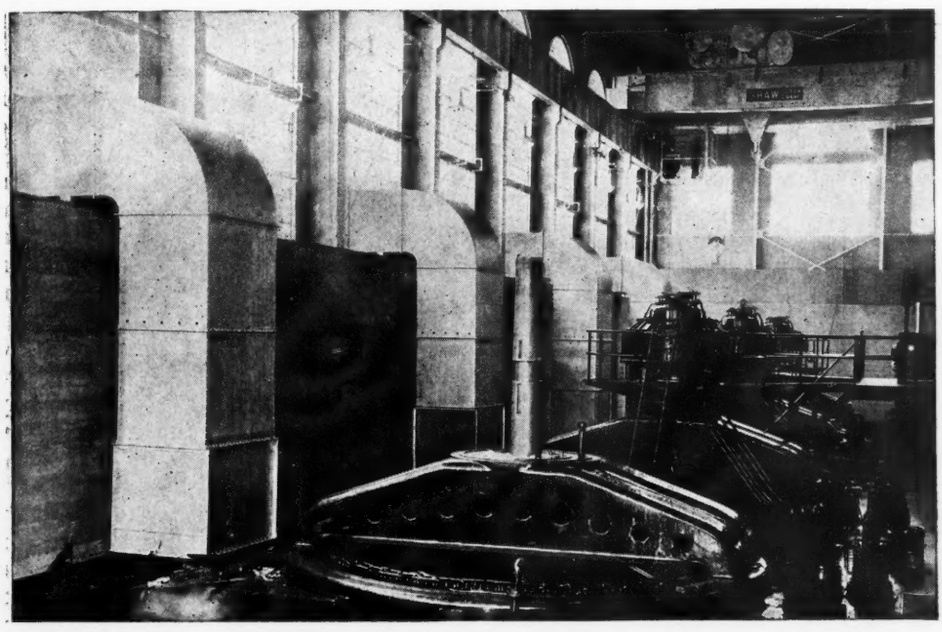
Before painting a special effort was made to stop all oil leaks, either by peening pin holes in welds or refitting pipe connections and by the use of No. 880 red oil-proof commutator cement on certain joints. This was also used in joints of cast gear-cases.

Application of the paint was by brush. Best results were obtained by making all final strokes in the same direction. Good results may be obtained by spray application, which in many cases is very economical if large areas of stone or cement are to be painted.

The covering qualities of aluminum paint were found to range, on steel work, from 350 sq.ft. per gallon on small intricate lattice work, to between 700 and 800 sq.ft. on smooth-surface steel tanks.

For exterior wood painting, such as stairways, boat landings and boats, the spar varnish vehicle is to be preferred. For painting operators' dwellings the prime coat is composed of a vehicle of kettle-bodied linseed oil and 2 lb. of aluminum bronze powder per gallon of vehicle. The kettle-bodied linseed oil is first mixed with volatile thinner in the proportion of six parts of oil to four parts of thinner, with the addition of sufficient drier to make the paint set to touch in from 6 to 10 hr. These proportions should be good for pine. For open-grained lumber, such as poplar, or badly weathered wood, the powder may be cut to from $1\frac{1}{2}$ to $1\frac{3}{4}$ lb. per gallon of diluted vehicle. This is for the priming coat only. For all exterior wood surfaces, except dwelling houses, three coats of aluminum paint are applied. It is interesting to note that aluminum shingles are used on the permanent buildings and aluminum gutters and downspouts on all buildings expected to remain ten years or longer.

Trouble may be experienced with all kinds of paint in the vicinity of electrical apparatus. Two precautions are advised. Do not allow paint to get on any insulating surfaces. Many believe that because they paint the insulating washers on brush-holders around 125-volt motors they can do likewise on high-voltage equipment. Almost any paint is a fairly good insulator up to 300 volts. Above 300 volts an arc will tend to jump between the varnish film surrounding any type of pigment; therefore, paint becomes a good conductor at high voltages. The other precaution concerns the possibility of paint contaminating insulating oil used in oil-filled electrical apparatus. It is almost impossible to prevent paint entering oil-filled apparatus when the paint is applied by a spray gun. Around transformers of some types there are breathers, and there may be loosely fitted covers or broken gaskets. On oil circuit breakers there are usually many openings for the expulsion of gases and to permit operating rods to enter the breaker tanks. While these openings are arranged so that rain water will not enter them, the spray-gun may force the paint into an opening that will shed rain. The solution to these problems is obvious and simple: A spray gun should not be used around the tops or joints of oil-filled apparatus. The paint may be applied as readily and cheaply around the top of such apparatus with a brush. Insulators should be wrapped with paper or cloth to prevent paint dropping or blowing on their surfaces. When applied with a brush, the paint film will assist in sealing the edges of gaskets or cover plates and man-holes. Aluminum paint with a spar varnish vehicle, applied with a brush, has been used with entire success for several years for sealing leaky gaskets in large oil circuit breakers operating at 154,000 volts.



The interior steel work, including the crane, of power houses is painted with aluminum paint, as is all electrical conduit, which blends well with nearly all color combinations. Oil, air and water piping is painted according to a color code for convenience and safety

Royal York Hotel

Generates Part of Its Power *from* Purchased Steam

By Philip C. Bradshaw
Toronto, Canada

The Royal York hotel, opposite the Union Station, Toronto, Canada

IN PURCHASING steam and power for the Royal York, the largest hotel in the British Empire, E. W. Beatty and the other directors of the Canadian Pacific Railway Company, responsible for the decision, were undoubtedly influenced by the fact that such a course was certain to eliminate the dirt and dust that are inseparable complements of the handling of coal and ashes, save the valuable space the installation of boilers and their auxiliaries would require, and reduce the initial outlay for equipment.

In the final analysis of steam and power costs, it is probable that the determining factor was the railroad's part ownership of the source of steam supply, the Toronto Terminals Railway Company plant, whose battery of eight boilers, now in course of erection, is to supplant the old Scott Street station of the Toronto Hydro Electric System, which now supplies the steam needs of the Dominion's newest hotel, the Union Station, general post office, and the railway's express buildings.

The average steam load during the summer for kitchen, laundry, refrigerating, air compressor, and ventilating systems is around 25,000 lb. an hour. In winter, with the addition of 65,000 sq.ft. of direct and 10,000 sq.ft. of indirect radiation, the steam load is about 40,000 lb. an hour, the system being designed for a maximum capacity of 72,000 lb. an hour.

Before describing some of the features of the mechanical equipment it may be well to give the estimate of H. Burt Foote, mechanical superintendent for Ross & MacDonald, Inc., Montreal, designers of the hotel, as to the saving in first cost, which had some bearing on the buying of steam and alternating current, the latter of hydro generation, converted into direct current by motor-generator sets in the Royal York.

Mr. Foote said: "Four 4,000-sq.ft. boilers would, in my opinion, have been necessary. With the other auxiliaries, such a plant would require space worth $200,000, to which would have to be added excavation required for settings, stokers, coal storage, and ash-handling equipment, entailing an outlay of, roughly, another $175,000, or $375,000 in all.

"On the other side of the ledger, of course, credit must be given for the tunnel, supply mains, etc., not as great an offset, however, as would at first appear, because the Union Station is across the street.

"Assuming, therefore, that the steam could have been produced for around 50c. a thousand pounds, the removal of the boiler plant from the hotel, with the saving in space, elimination of dirt, attendants and supervision would be easily worth an additional 20 to 50c. per thousand pounds of steam consumed."

Steam is brought to the building at a pressure of 170 to 180 lb. in two mains, an eight-inch for summer use and a ten-inch main for the winter. The steam supply can be classified under four heads: high-pressure system, high - intermediate - pressure system, low - intermediate - pressure system, exhaust and low-pressure system.

The high-pressure steam-distribution system consists of the eight- and the ten-inch lines, already referred to. They connect in a loop supplying the engine-generator sets, ammonia and air-compressor engines, fire pump, etc.

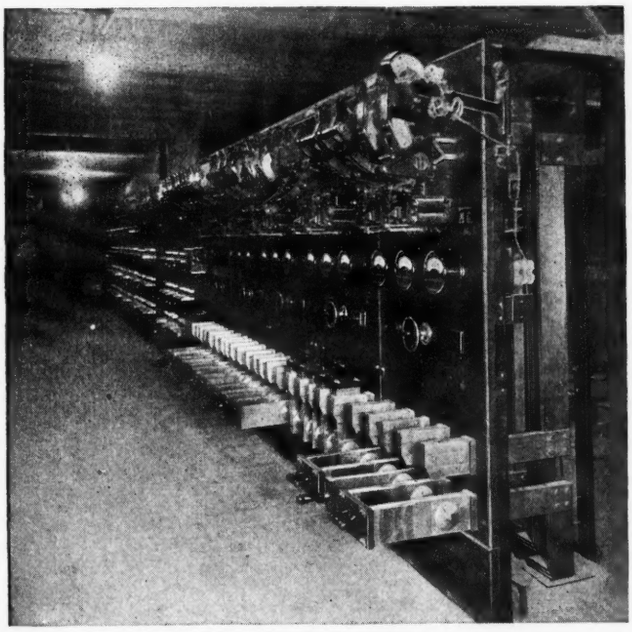
Starting at the reducing valves, the high-intermediate-pressure system consists of a main on the ceiling of the engine room and sub-basement, carrying steam at 100-lb. pressure to the laundry and valet's room, and then to the reducing valves of the low-intermediate-pressure and the low-pressure systems for both direct and indirect heating units, and water softener.

The low-intermediate-pressure system supplies all apparatus requiring steam at 40-lb. pressure, in pastry room, candy and bake shops, help's kitchen, coffee and grill room, kitchens on the basement floor, main kitchen, private dining room, service, banquet room kitchen, roof garden, dish pantry and kitchen, and the barber shop.

The exhaust and low-pressure steam-distributing system consists of a main in the pipe tunnel under the engine room floor, with its end connected to a combined muffler tank and oil extractor, from where it rises to the

ceiling of the engine room. Branches to domestic water heaters, direct and indirect heating units, distribute the steam at 2-lb. pressure to approximately 75,000 sq.ft. of equivalent radiation. The main then rises to the roof and terminates in a back-pressure valve and exhaust head. A sub-main is taken from the vertical riser, near the ceiling of the convention hall, and connections are made to indirect heaters on the convention mezzanine floor.

The direct heating system is divided into three main subdivisions, two of them fed from the main in the sub-basement, the third from a branch taken from the vertical riser at the seventeenth bedroom floor. The returns from all direct radiation are connected through sub-branches and risers to return mains below the ceiling of the sub-basement for the first two of the heating-system sub-divisions, and in the pipe and duct space at the ceiling of the convention mezzanine floor, as well as in the ceiling of the kitchen on the convention hall floor, for the third sub-division. The return main for each of the divisions is connected to individual duplex vacuum pumps, located in a supply fan room in the sub-basement. The returns from all indirect heaters are connected to separate vacuum pumps in the same fan room. Condensate from the domestic water heaters is handled by a



Distribution of electric energy is controlled from this 22-panel 56-ft.-long switchboard

duplex vacuum pump in the engine room. The discharge from the five vacuum pumps is collected in the engine room in a receiving tank, from which it is pumped back to the boiler plant.

The steam supplied to the radiators in each of the three main subdivisions may be independently varied to provide for changes in demand resulting from variations of outdoor temperature, and wind velocity, and from variations of steam pressure and vacuum in the return. Manual control of the steam supply is provided to take care of changes in demand resulting from changes in weather conditions other than temperature and to provide for quick heating-up and night load conditions.

Three outside roof thermostats automatically adjust the steam supply to each zone to meet the requirements of outside temperature conditions. Each of these roof thermostats controls the air pressure, which actuates sylphon bellows that mechanically operate oil pilot valves located at the control for each zone. Movement of the oil pilot valve in one direction sends additional oil to the operating piston of the main zone control valve, opening this valve and increasing the steam supply until the difference in pressure between the supply and return in that zone is maintained equal to the air pressure in the line between the thermostat and control board.

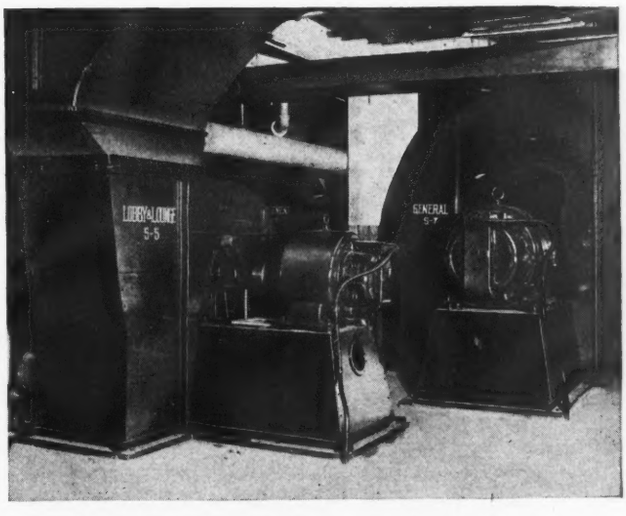
Orifices are installed in the inlet to each radiator and in branch supply lines, to insure equal distribution of steam through all sections of each zone.

To take care of the water required in the hotel for cooking, laundry, domestic service and refrigeration, a 6-in. and an 8-in. main are brought into the engine room in such a manner that the water can be supplied through one or the other, or carried through both at the same time. City pressure varies from 90 to 100 lb., and is used to deliver the water up to the seventh bedroom floor, except in the basement, where the pressure is reduced to 45 lb. For higher levels two double-suction centrifugal pumps raise the water to storage tanks on the roof, from where it is fed by gravity down to the eighth floor.

The hot-water supply of the building is taken care of by six storage heaters, each of 6,000 gal. capacity, that can heat the water to 180 deg. in one hour, thus giving a capacity of 36,000 gal. of hot water per hour. The temperature is controlled by thermostats set for the required limit.

Alternating current is brought into the hotel by two 2,300-volt, 3-phase, 25-cycle lines. On two panels of the switchboard are mounted three 2,300-volt, 300-amp. circuit breakers, each having an interrupting capacity of 150,000 kva., mechanically interlocked to control the two primary incoming cables. Three 125-kva. self-cooled transformers reduced the voltage from 2,300 to 115 and 230 volts for emergency lighting.

To eliminate flickering, direct current is used for lighting, and for the motors to permit speed control. It is converted by two 400-kw., 120-240 volt generator sets driven by 500-r.p.m. 2,300-volt, 3-phase, 25-cycle, self-starting synchronous motors. In addition to the two motor-generator sets there are three 400-kw. sets, driven by steam engines of the compound, two-crank, vertical type, operated at approximately 375 r.p.m., with a steam



Part of the ventilating of equipment in the Royal York

pressure of 180 lb. and a back pressure of 3 lb. per square inch, in parallel with the motor-generator sets.

In winter the exhaust from the engines is used for heating purposes, and the proportion of load carried by the respective sets varies to meet the heating demand and to secure maximum economy.

Cooking throughout the hotel is done electrically. Alternating current for this purpose is supplied by the three 125-kva. single-phase transformers and fed through three-pole double-throw switches, which make direct current available when desired.

Three ammonia compressors, driven through flexible couplings by uniflow engines, furnish 120 tons of refrigeration for ice box and other kitchen requirements. There is also a four-ton electrically controlled refrigerating system in the tower to meet the requirements of a roof garden kitchen. There are two air compressors, one a two-stage machine driven by a 40-hp. motor at 375 r.p.m., the other a steam-driven machine. The capacity of these machines is 250 cu.ft. per minute.

Two direct-connected electrically driven centrifugal brine pumps with a capacity of 400 g.p.m. circulate brine through the refrigerators in the several kitchens, and two 150-g.p.m. pumps circulate brine through the ice cream and sharp freezers.

The ventilatiing system of the hotel requires eleven supply and eighteen exhaust fans. Four air washers cool and clean the air supply for the main and private dining room, cafe, grill, lobby, lounge and a few rooms in the sub-basement. The supply air to all other rooms passes through oil air filters. Heating stacks are provided at both air washers and oil air filters to heat the air during the winter.

Approximately 310,000 cu.ft. of air per minute is handled by the fresh air supply fans, seven being located in the basement and the remaining four on the convention floor level. Extending from the basement up to the first break in the building, 75 ft. above the ground, is an air-intake shaft, so that fresh air is not obtained near the street level.

The exhaust fans, which have a total capacity of 440,000 cu.ft. of air per minute, are located on the 13th bedroom floor and in the first, second and third elevator towers. The exhaust fans located on the 13th bedroom floor exhaust through the room at the 14th floor setbacks. The fans in the elevator towers exhaust through a plenum chamber in the hotel tower, from where it is allowed to discharge to the atmosphere through copper louvers. The exhaust fan for all the kitchens is independent of the other fans and has a separate exhaust discharge.

No refrigeration is used in connection with the ventilation system. The horsepower of the different motors employed to drive the fans varies from 3 to 16 and totals approximately 200 horsepower.

The fan casings and ducts are made of galvanized iron. Some of the ducts are 12 ft. wide and extend from the basement to the tower. All the heaters connected with the ventilating system are thermostatically controlled, and the speed of the supply and exhaust fans is manually controlled.

It will be noted that the volume of exhaust air expelled is much greater than the volume of fresh air entering. This makes it possible to have a steady stream flowing into the kitchen from other parts of the building and thereby rid that area of offensive odors that would otherwise permeate the hotel.

Principal Equipment in the Royal York Hotel

General

Architects and engineers.....Ross and MacDonald, Inc.
General contractors .....Anglin Norcross, Ltd.
Number of rooms..... 1,015
Height of building, street to roof, ft..... 404½
Capacity of banquet hall..... 2,800
Capacity of convention hall..... 4,700
Capacity of main dining room..... 500

Engine Room

Engine-generator sets, three 400-kw. engines, compound, two-crank, vertical-type..Belliss & Morcom Co.
Generators, 120-240-volt, 3-wire direct-current, 375 r.p.m..Lancashire Dynamo & Motor Co. of Canada, Ltd.
Motor-generators, two 400-kw.
Motor, synchronous, 6-pole, 500-r.p.m., 2,300-volt, 3-phase, 25-cycle
Generator, 500-r.p.m., 120-240-volt, 3-wire, direct-current.....Lancashire Dynamo & Motor Co. of Canada, Ltd.
Air compressors, two, two-stage, 225-c.f.m.
One engine-driven at 375 r.p.m.
One motor-driven at 275 r.p.m.....Browett-Lindley Co.
Air receiver, 48-in. dia.....John Inglis Co., Ltd.
Muffler and oil extractor, 60-in. dia., 13 ft. long, 22-in. dia. steam inlet and outlet.....Kieley & Mueller Co.
Refrigeration—Three 40-ton ammonia compressor units, one four-ton unit, Linde Canadian Refrigeration Co., Ltd.
Engine drive for 40-ton pumps compressor.....Skinner Engine Co.
Fire pump, one Rees Roturbo centrifugal 1,000-g.p.m. at 200-lb. pressure, 2,400-r.p.m., driven by steam turbine .....Goldie & McCulloch Co., Ltd.
Ejectors, two, duplex centrifugal, motor-driven Yeoman Bros. Co.
Vacuum pumps, five, duplex "Hytor" vacuum heating pumps, discharge pressure 10 lb. Nash Engineering Co.
Motor drive .....Canadian General Electric Co., Ltd.
Condensate return pumps, two motor-driven centrifugal, 150-g.p.m., 25-lb. pressure, 1,600-r.p.m., to handle water at 212 deg.....Darling Bros., Ltd.
Motor drive Lancashire Dynamo & Motor Co. of Canada, Ltd.
Brine pumps, two 400-g.p.m., two 150-g.p.m., single-stage, 1,750-r.p.m., centrifugal.....Dayton Dowd Co.

Heating and Ventilating

Direct radiators, 65,000 sq.ft. Dominion Radiator & Boiler Co., Ltd.
Vento heaters, 10,000 sq.ft.....American Radiator Co.
Radiator traps .....Warren Webster & Co.
Radiator valves.....Jenkins Bros., Ltd.
Temperature control.....Powers Regulator Co.
Supply fans, eleven, multivane, Keith type...Sheldon's, Ltd.
Motor drive Lancashire Dynamo & Motor Co. of Canada, Ltd.
Exhaust fans, eighteen, multivane, Keith type.Sheldon's, Ltd.
Motor drive Lancashire Dynamo & Motor Co. of Canada, Ltd.
Air filters, six; total number of cells, 148 Midwest Canada, Ltd.

Water Heating and Softening

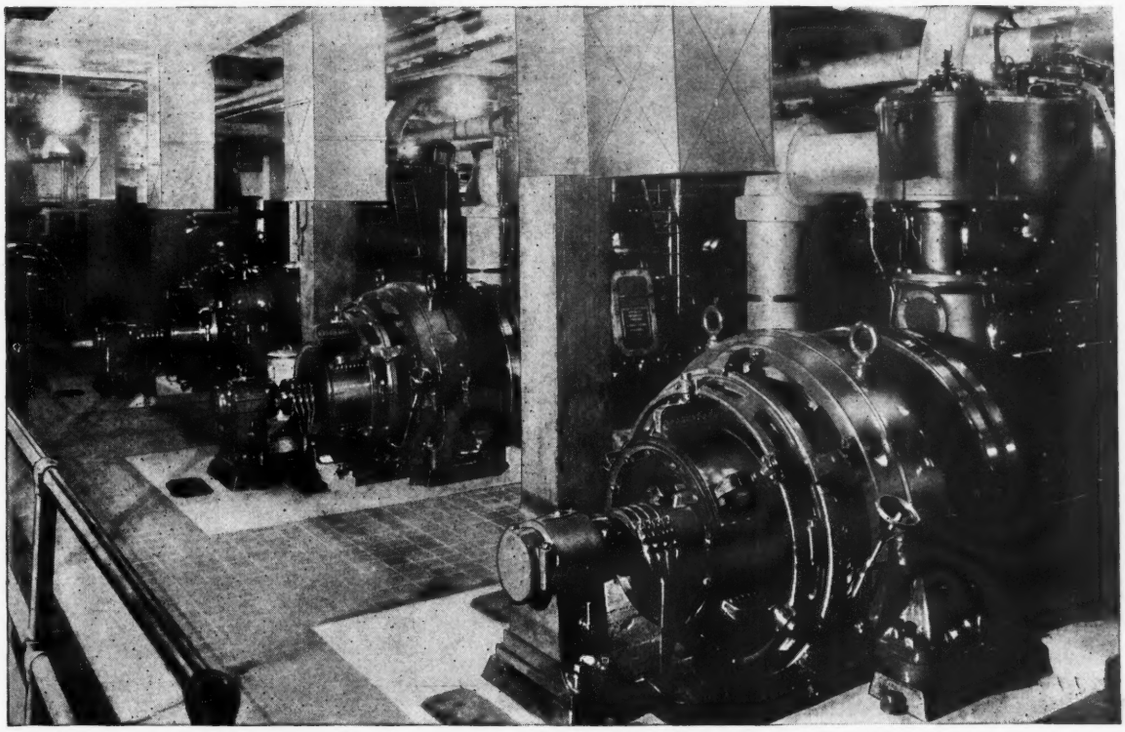
Water storage and suction tanks....R. McDougall Co., Ltd.
Water softening, two zeolite units, 17,000 gal. per hour, total capacity between regeneration 68,000 gal. per unit with water of 8 grains hardness per gal. .....W. J. Westaway
Water-heating incinerator, 3 tons of refuse per day .....Decarie

Meters and Instruments

Steam-flow meters, five.....Bailey Meter Co.
Water-flow meter, six-inch.....Neptune Meter Co.
Water-flow meter, eight-inch.....National Meter Co.
Temperature recorders .....Foxboro Co.
Liquid-level gage .....Peacock Bros.
Pressure gages.....Foxboro Co.
Maximum-demand meter.....Lincoln Motor Co., Ltd.
Weigh scales, two; one 5,000 lb., one 2,000 lb.....Canadian Fairbanks-Morse, Ltd.

Miscellaneous

Transformers, three, single-phase, 125-kva., 2,300 volts primary, 115/230-volt secondary, 25-cycle, oil-insulated .....Canadian General Electric Co., Ltd.
Traps .....Armstrong Machine Works
Pressure-reducing valves, five.....Boylston Co.
Atmospheric relief valve.....Cochrane Corp.
Exhaust heads .....Kieley & Mueller Co.
Insulation.....Canadian Johns-Manville Co., Ltd.
Small valves.....Jenkins Bros., Ltd.
Wrought-iron pipe.....Page-Hersey Tubes, Ltd.
Switchboard panels....Canadian General Electric Co., Ltd.
Steam separators .....Peacock Brothers, Ltd.



A view in the engine room, showing the three 400-kw. engine-generator sets

An unusual feature of the Royal York installation, at least as far as Canada is concerned, is the instrument board in the office of Chief Engineer A. W. Mason. This board, 13 ft. 6 in. long x 4 ft. 8 in. high, has 27 instruments, which give the chief engineer all of the information required to check the operation of the plant. These instruments indicate brine temperature, outdoor temperature, level of water in storage tanks on roof, fire protection pressure, city water pressure, hot-water temperature for kitchen and laundry, high and low brine flow and return temperature steam flow through lower and upper section steam mains, low-pressure heating, high-pressure intermediate steam to laundry, low-pressure intermediate steam to kitchen, 8- and 10-in. steam lines, ammonia suction pressure, ammonia discharge pressure, air pressure for power control system, high and low brine discharge pressure, compressed air, and maximum demand meter.

All high-intermediate- and low-pressure steam lines, hot- and cold-water piping, return lines, smoke flues, condensation tanks, heater casings, cold air intakes, etc., throughout the hotel are insulated with asbestos.

Bids on 350-Kw. Diesel-Generator Set

THE City of Ellis, Kan., in October, 1929, opened bids for a 350-kw. Diesel unit to supplement the present capacity of its municipal light plant. The data on the several bids are shown tabulated.

Engine builders, through a contractor, offered bids on the complete unit, with a choice of several generators. While the unit is for an existing plant, still the prices on the piping and cooling systems may be taken as representative of the costs in new plants of like capacity.

The guaranteed fuel consumptions are rather remarkable, in that they are almost uniform from full to one-half load; which may indicate that the generator is more efficient at three-quarters than at full load, or that the engines were able to do much better than the full load guarantees.

The piston speeds range from 900 to 1,000 ft. per minute, and the rotative speeds of 225 to 257 indicate the tendency toward higher rotations. In weight there is but slight difference, with the exception of the two-stroke-cycle engine.

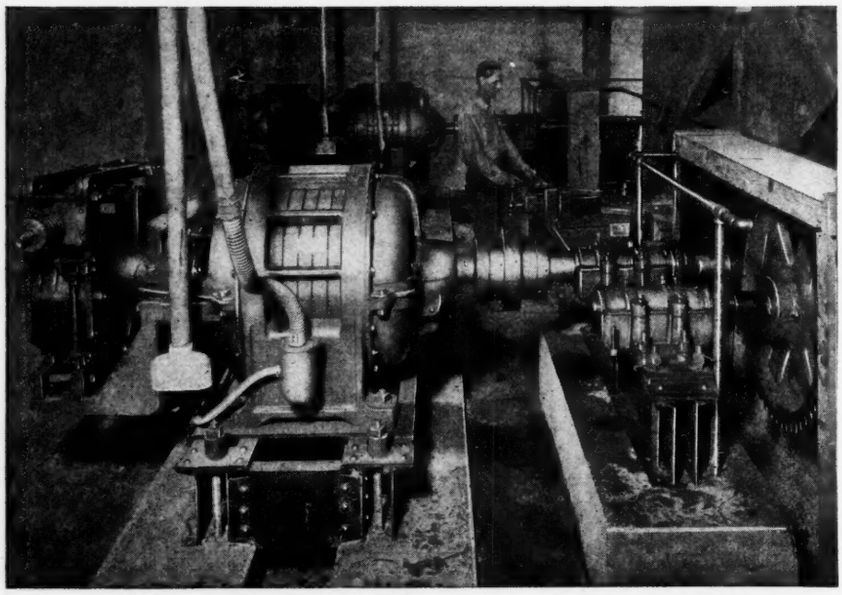
The several bids are very uniform as to price, being approximately $100 per kilowatt of capacity.

The contract finally entered into specified a McIntosh & Seymour engine.

TABULATION OF BIDS FOR 350-KW. OIL ENGINE GENERATING UNIT

	I. P. Morris-DeLaVergne	McIntosh-Seymour Corp.	Worthington Pump and Machinery Corp.		Fairbanks, Morse & Co.
350-kw. engine with generator as noted:[1]					
Allis-Chalmers	$36,793.00	$31,235.00	$33,170.00	$37,766.00	.....
Westinghouse	36,858.00	31,235.00	32,740.00	37,596.00	$34,950.00[1]
Elliott	36,903.00	31,285.00	.....	.....	.....
General Electric	37,093.00	31,360.00	33,221.00	37,766.00	4,100.00
For closed cooling system	$3,968.00	$3,968.00	$3,968.00	$3,968.00	.....
Wiring and conduit	556.00	556.00	556.00	556.00	400.00
Plant piping	1,925.00	1,925.00	1,925.00	1,925.00	2,200.00
Fuel guarantees, lb. per kw.-hr.:					
Full load	0.64	0.624	0.606	.....	0.613
¾ load	0.64	0.654	0.622	.....	0.638
½ load	0.66	0.73	0.704	.....	0.684
Brake, horsepower	550	500	480	600	560
Weight of flywheels, lb.	16,000	15,000	23,000	.....	9,200
Total weight of engine, lb.	150,000	140,000	160,000	.....	96,959
R.p.m.	240	225	225	.....	257
Number of cylinders	5	4	4	.....	4
Diameter of cylinders, in.	17	17⅜	17	.....	16
Length of stroke, in.	24	25	25	.....	20
Diameter of crankshaft, in.	11	10½	11	.....	10
Number of crankshaft bearings	7	5	5	.....	5
Size of crankshaft bearings, in.	10½x10½	10½x14¾	11x12	.....	10

[1] Fairbanks, Morse & Co. generator.



Two 225-hp. induction motors geared to aerial cableway.

Permissible SPUR-GEAR SPEEDS *for Motor Drives*

By R. F. EMERSON
General Electric Co.
Industrial Engineering Department

The higher efficiency and power factor of high-speed motors make them preferable to slow-speed types for many applications. When high-speed motors are used with gear speed reducers there are limits of gear speeds that should not be exceeded for satisfactory operation. Permissible gear speeds are influenced by several factors. If the application engineer must exceed standard limits of speed there are certain expedients that may be incorporated in the installation to prevent trouble, as explained in this article.

THERE are several advantages in using high-speed motors for mechanical drives. First, the lower initial cost. A 50-hp., 1,200-r.p.m., wound-rotor induction motor may cost 75 per cent less than the same size motor operating at one-half the speed. Generally, high-speed motors will have a higher efficiency and power factor at all loads than slow-speed motors. Referring to Fig. 3, it will be noted that the efficiency curve of the 50-hp., 1,200-r.p.m. motor is generally higher than that of the 600-r.p.m. machine, and the power factor at all loads for the 1,200-r.p.m. motor is considerably better than that of the low-speed unit.

Among the disadvantages of a high-speed motor drive may be mentioned: a larger gear ratio is required between the motor and the driven machine; a lower mechanical efficiency, particularly if an extra gear reduction is necessary; more space required for gearing; usually more power or longer time required to accelerate; more wear on the solenoid brake, if used; in cases where acceleration is frequently repeated, the power demand may require greater current-carrying capacity in the control equipment instead of less, as previously mentioned.

In further explanation, consider two wound-rotor motors, each rated at 30 hp., but one having a speed of 1,140 r.p.m. and the other 845 r.p.m. The high-speed motor has a lighter rotor and its WR^2 is 21 as compared with the slow-speed motor's WR^2 of 26. However, because the lighter rotor must be accelerated to 35 per cent greater speed, the horsepower torque required to accelerate it is 47 per cent greater than required for the slow-speed rotor, as shown below. The calculations are made on the assumption that both motors are accelerated to full speed in the same time, which, for simplicity, will be taken at one second.

$$Hp.\ torque = \frac{WR^2n^2}{448t} = \frac{21 \times (19)^2}{448 \times 1} = 16.9$$ for the 1,140-r.p.m. motor.

$$Hp.\ torque = \frac{WR^2n^2}{448 \times 1} \quad \frac{26 \times (14.1)^2}{448 \times 1} = 11.5$$ for the 845-r.p.m. motor.

Where n = revolutions per second of the motor,
and t = time in seconds required to accelerate the rotor.

The foregoing means that for fast-duty cycle work, where there is a large proportion of accelerating as compared to free running and rest periods, there may be greater power taken from the line by the high-speed motor. If the motor is controlled by current-limit relays, the high-speed motor will take longer to accelerate a given load up to full speed than the slow-speed machine. Also, due to the larger amount of stored energy in the lighter rotor, there will be more wear on the solenoid brake when retarding the rotor. If the motor is used for continuous running service, such as driving a conveyor, pump, or fan, most of the foregoing mentioned disadvantages disappear.

The most favorable condition under which a high-speed motor can operate is coupled direct to the load. The driven machine should be self-contained on its own bearings so as not to impose any additional stresses on the motor bearings. The motor should run continuously in one direction without being subjected to numerous starts and stops or reversals by plugging.

On the other hand, if the high-speed motor is geared to its load, having a pinion mounted on a shaft, and if

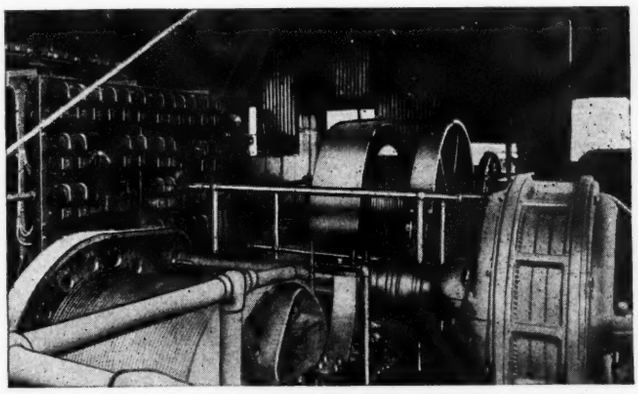


Fig. 1—Resistors and direct-current panels control induction motors geared to coal hoist

it is subjected to numerous accelerations and reversals, there are certain factors to be considered. Instances of trouble of various kinds are on record where these factors have not been given proper consideration by those responsible for designing the gear trains and applying the motors.

With high-speed motors and keeping the diameter of the pinion as small as the necessary mechanical strength over the keyway will permit, it may be found that the pitch-line velocity or peripheral speed in feet per minute of the pitch circle of the pinion (or sprocket, in the case of chain drive) is higher than dictated by the best practice. The N.E.M.A. has recognized the fact that a high-pitch line velocity in the case of gearing is undesirable, and according to its new recommended practice the peripheral speed for steel spur gears used with electric motors should not exceed 1,300 ft. per minute. It is recognized that the vibration caused by impact of gear teeth above this speed may cause troubles by:

1. Pitting the slip rings and commutators from brush chatter.
2. Pounding out the bearings and deforming the air gap, particularly in the case of induction motors where the air gap is small.
3. Fatiguing the shafts.
4. Grounding the windings where coils leave the slots.
5. Loosening the rotor laminations.

Obviously, it is impossible to select arbitrarily a certain peripheral gear speed and to state that all speeds less than this will give satisfactory motor operation and all speeds above this limit will give trouble. What it means is that experience has shown the average geared job can be expected to be reasonably successful when speeds do not exceed this value, but for installations using higher speeds the chances for good operation grow less the higher the peripheral speed. In the past few months, the following cases developed where trouble evidently came from high gear speeds:

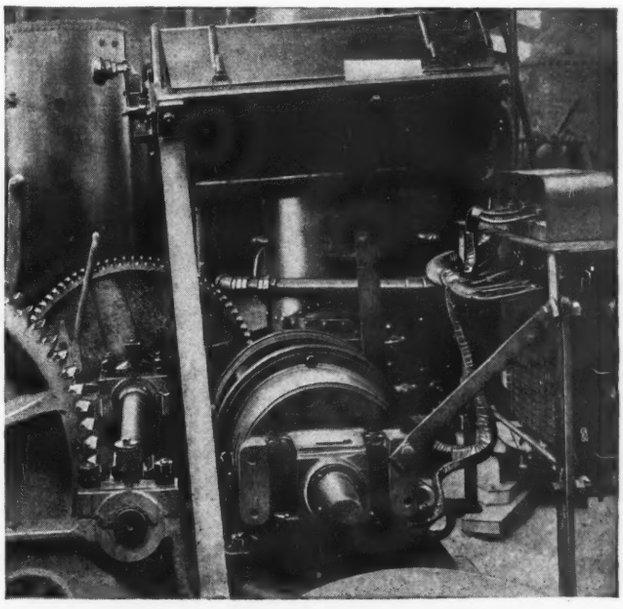
Two hoist installations were equipped with induction motors of two different makes. Bearings were being hammered severely, and vibration resulting from gear-tooth impact at high speed was causing the motor insulation to break down. This forced numerous shutdowns and delays. Both motors were geared with overhung pinions the pitch-line velocity of which was around 2,000 ft. per minute. Both motors were replaced by units using outboard bearings, and operated successfully.

Another case of trouble involved a 150-hp. induction motor operating a drag-line scraper reclaiming coal for a power station. The gear pitch-line velocity was 1,900 ft. per minute, but the installation of an outboard bearing corrected the trouble.

In a recent issue of a technical magazine, a description is given of bearing trouble. This motor had an overhung pinion and was geared to its load. It required an excessive number of bearing replacements. This not only interrupted production, but was the cause of excessive maintenance expense. The trouble was remedied by using an outboard bearing. The comment was made that if an extended shaft and outboard bearing had been used originally, the extra cost would have been much less than was necessary to correct the difficulty, to say nothing of the high maintenance charges for trying to keep the motor running when using the overhung pinion. Where there is sufficient room for an outboard bearing, it will sometimes make all the difference between successful and unsuccessful operation if the peripheral speed of the pinion is higher than 1,300 ft. per minute.

The foregoing incidents do not indicate that an outboard bearing is a panacea for all vibration troubles

Fig. 2—Motor connected to hoist through double gear reduction



caused by high gear speeds, but they do show that in cases where the gear speeds exceed 1,300 ft. per minute it may still be possible to get reasonably good operation. Extreme cases of high gear speeds and coarse gear teeth may require independent bearings on each side of the pinion and a flexible coupling for the motor.

To avoid high pitch-line velocity without lessening the motor speed, it is necessary to reduce the size of the motor's pinion. The minimum permissible pinion diameter is limited in two ways: The smaller the pinion diameter, the greater the thrust on the motor bearing. Too small a pinion may cause overheating of the bearing. It is possible to reduce the diameter to a point where there is insufficient stock in the pinion and it is likely to break. That is why small motors with their smaller shafts permit the use of smaller size pinions, which, in turn, allows gearing higher speed motors in the smaller sizes without exceeding a safe pitch-line velocity.

In addition to the pitch-line velocity, the choice of pitch should also be considered. In general, the finer the gear pitch, the quieter and the less subject to vibration will be the installation. But a coarser pitch gear is usually lower in first cost. If a certain gear train is laid out with the peripheral speed of the motor pinion approaching close to the limits of good practice, successful operation may be more surely attained by keeping away from the coarser pitches. In the past, it has been the practice to give approximate recommendations of pitches for certain horsepower ratings. This is of comparatively slight value, because the pitch and thickness of the teeth should be decided according to the applied torque regardless of speed. The formula for torque is:

$$T = \frac{Hp. \times 5{,}250}{r.p.m.}$$

This shows that the torque is the same for a 20 hp. 1,800-r.p.m., a 10-hp. 900-r.p.m., or a 5-hp. 450-r.p.m. motor.

Gears made of non-metallic material, such as Fabroil or Textolite, are resilient, quiet, and may be employed

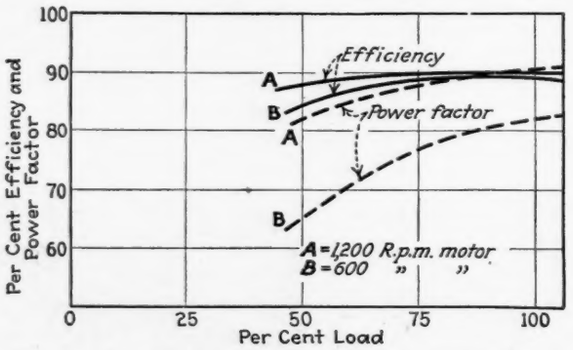


Fig. 3—Comparison of efficiency and power-factor curves of a 1,200- and a 600-r.p.m. motor

with a stress factor in the Lewis formula of 6,000 to 8,000 lb., the same as good cast iron. Where loads are not so severe as to require gear material with a greater stress factor than this, it will be found that these materials cushion load shocks and vibration to a great extent. The use of pitch-line velocities up to 3,000 ft. per minute is not unusual in industrial installations using non-metallic materials. Complete success has been attained with Fabroil in applications where the pitch-line velocity was several thousand feet per minute and where load conditions did not demand the use of gear material with a stress factor in excess of 8,000 pounds.

The question is sometimes raised as to why it is possible to gear direct-current motors at speeds above those recommended for induction motors. In some cases direct-current motors are guaranteed for successful geared operation using an overhung pinion with two-bearing construction; whereas an induction motor of the same horsepower, rating and speed is not recommended for geared operation unless an outboard bearing is also included. For example, a direct-current crane motor rated 125 hp. (30 min. 55 deg. C.), 675 r.p.m., is recommended for gearing using two bearings; while an induction motor for the same kind of service rated at 100 hp. (60 min. 50 deg. C.), 600 to 575 r.p.m., is listed with an outboard bearing for geared operation.

In the first place, a comparison of the general design and mechanical construction of a typical direct-current crane motor will show that it is inherently more rigid than an alternating-current type. Also the frame is

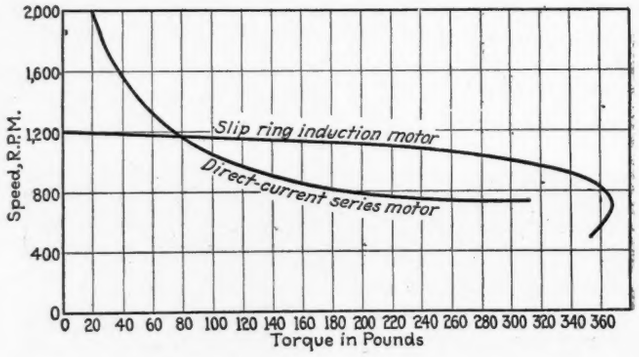


Fig. 4—Comparison of speed-torque curves of a direct-current series motor and a slip-ring induction motor

totally inclosed, and the shaft extension for the pinion is close to the armature spider. With the direct-current motor, there is a large air gap, so that ordinary flexing of shaft or wearing of bearings is not so serious.

Another factor to be considered is the difference in the speed-torque characteristics of the two types of motors. Fig. 4 shows the speed-torque curves of an alternating-current motor and a direct-current motor used for hoist work. If an alternating-current motor and a direct-current motor are being considered for a hoist, it is reasonable to consider an induction motor with a full-load speed intermediate between the light-load and the heavy-load speed of the direct-current series motor. The curves show that at heavy loads, when the bad effects of coarse gear teeth and high peripheral gear speed are the most pronounced, the direct-current motor slows down, and to a considerable extent nullifies this effect. On the other hand, the induction motor is virtually a constant-speed machine, and its pinion will operate at a higher peripheral speed at heavy loads than the series motor. It is true that on light loads the series motor reaches a speed considerably above that of the induction motor; but because the load is light the vibration effect is considerably reduced.

Carefully cut herringbone gears successfully operate at gear speeds as high as 5,000 ft. per minute.

Silent chain drives on hoists are now becoming quite common where formerly only geared drives would be considered. The trend toward this type of drive has been mainly due to the fact that it can run quietly and at high speed, with more teeth in working contact resulting in smoother action. Unless all the conditions of operation are known, it is not safe to exceed the N.E.M.A. ruling of 1,300 ft. per minute.

Controlling Bled Steam

Without Frequency Fluctuation

The requirements of turbine bleeder-pressure regulators have been increased from a previously rather indifferent control to the present-day need of holding the bled steam pressure within close limits and at the same time maintaining the electrical frequency with change in bled steam demand

By S. H. Hemenway
Westinghouse Electric & Manufacturing Company

SINCE the earliest installations of turbines in industrial plants, it has been realized that it was more economical to pass steam through a turbine and obtain useful work in reducing it to the required pressure than to get the low-pressure steam by means of a pressure-reducing valve in the boiler steam line.

This led to the introduction of the bleeder-type turbine that passed steam to the low-pressure line and regulated its pressure. A bleeder mechanism used about 1911 is shown in Fig. 1. With this mechanism steam is bypassed from the bleeder zone *B* (to which the bleeder pipe is connected) to the low-pressure stages of the turbine, at *C*, by raising the piston valve *A*. Whenever more steam is being passed to satisfy the load requirements than is needed to satisfy the bleeding requirements, there results an increase of pressure at *B*, which raises the piston *A* against the balance weights *D*. The bypass valve *A* acts as its own operating piston. The pressure at which the machine will bleed is determined by the weights at *D* and *F*, the weights at *F* being mainly to reduce the load against which the piston *A* must operate. When desiring to operate for a considerable time without bleeding, the valve *A* is raised by the handle *G*. This eliminates the throttling loss across the valve, and gives better efficiency.

A later type of bleeder control, in use until three or four years ago, is shown in Fig. 2. With this the steam passing to the lower stages of the turbine (from the bleed point to the condenser) is regulated by a grid valve. The grid valve is moved by a steam-operated piston *A*, controlled by a relay valve *B*, actuated by a diaphragm *C*, as shown. With this type of regulator an increased bled-steam demand causes the grid valve to close, allowing less steam to go to the exhaust, hence passing more steam to the bleeder line and raising the pressure in that line. However, due to passing less steam to the exhaust, less work is done, and the turbine frequency drops a sufficient amount to cause the governor to open the steam chest valves to again carry the same load when bleeding the increased amount. This change in frequency also obtains with the mechanism shown in Fig. 1.

The bleeder performance of a 1,000-kw. turbine may be represented by Fig. 3. If this turbine is operating

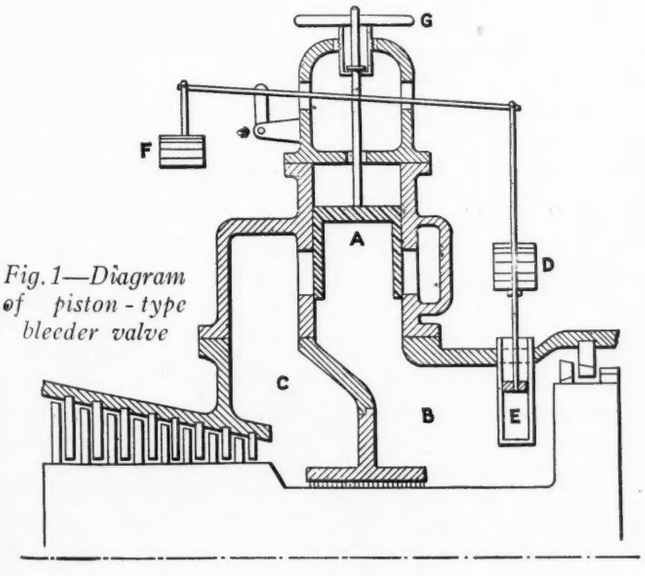


Fig. 1—Diagram of piston-type bleeder valve

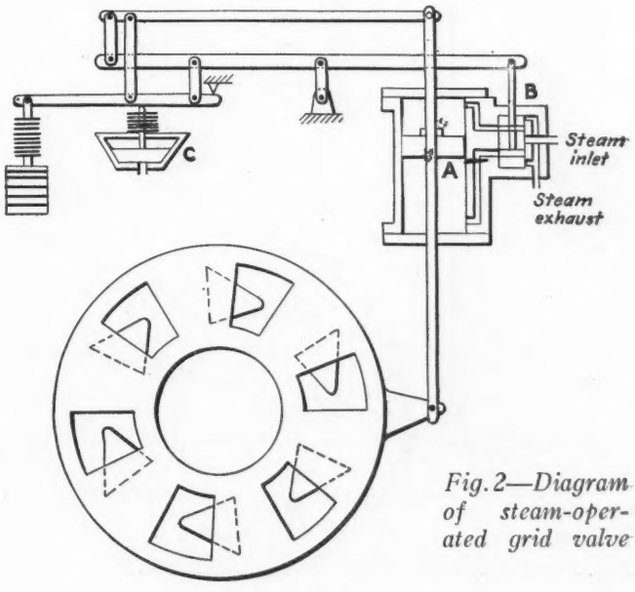


Fig. 2—Diagram of steam-operated grid valve

at 750-kw., bleeding 10,000 lb. per hour, the total steam to throttle is 19,500 lb. per hour, as shown at *A*. If the bleeder demand increases to 35,000 lb. per hour, as shown at point *B*, the throttle flow will be 38,000 lb. per hour.

The inherent speed regulation is shown in Fig. 4. If the speed-changer is so set that the speed when passing 19,500 lb. per hour is 60 cycles, the speed when passing 38,000 lb. per hour will be 58.6 cycles. After this change in bleeder demand, the speed changer can be reset for 60 cycles, in which case the whole curve moves up, and point *B* becomes B^1.

With the more general adoption of electric drive in the paper and other industries, this change in frequency with change in bled steam demand caused breaking and unevenness of the product, and could not be tolerated. For this reason it was necessary to develop a bleeder control that would act on the governor to prevent the frequency from dropping to the value *B*, and would, in fact, shift the regulation curve from the line *A B* to the line $A^1 B^1$. This cannot be accomplished without some change in the frequency, but the frequency does not drop to as low a value as *B*, and is maintained within close limits of the original frequency.

At about this same time, there was an accelerated movement to increase the efficiency in all branches of industrial processes, leading to the use of higher steam pressures, which would allow more byproduct power to be developed from the steam before its use in the process lines. As high-pressure steam at high temperature is a difficult medium to use in the operating cylinder of a bleeder mechanism, oil was adopted as the operating medium, and proved to be exceedingly well-adapted to the compensated bleeder control, which was the name given to the control that compensates for the change in bleeder steam demand by increasing or decreasing the steam flow to the high-pressure stages of the turbine at the same time it operated the bleeder valve.

A diagrammatic view of this apparatus is given in Fig. 8, with the arrows showing the direction of movement of the valves for an increase in bleeder demand. It will be noted that the main governor admits more steam to the turbine when the grid valve closes to send more steam to the bleeder line. There is still an inherent

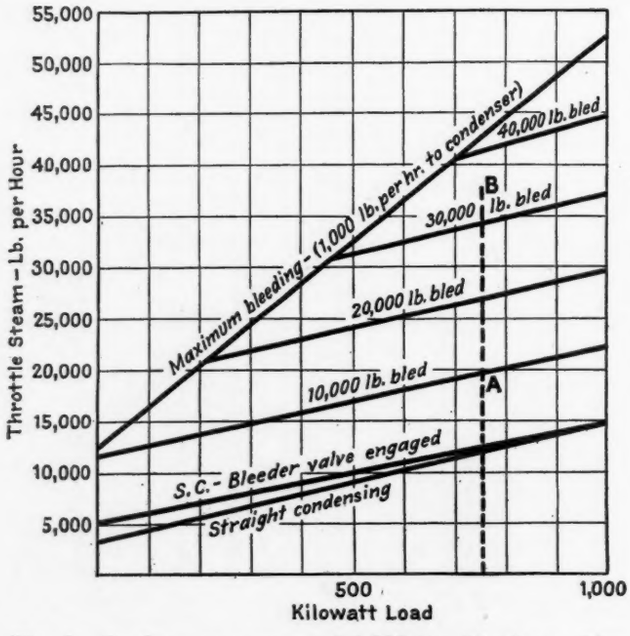


Fig. 3—Performance curve of 1,000-kw. bleeder turbine

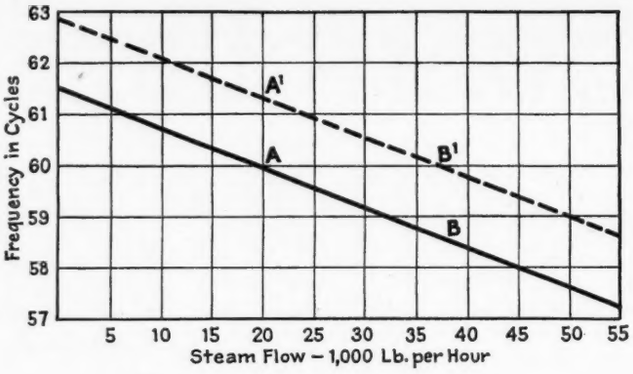


Fig. 4—Inherent speed regulation

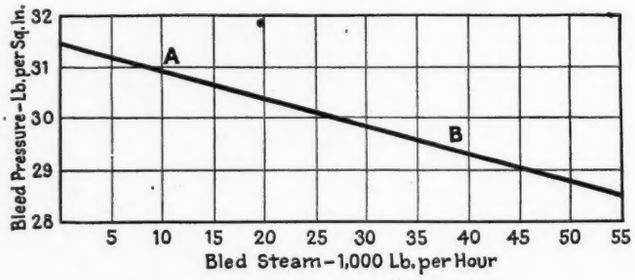


Fig. 5—Bleeder pressure characteristic for extraction turbine

speed variation with change in load; but at any constant load a change in bled steam demand causes only a negligible change in frequency.

With any method of control of steam pressure it is necessary to have some "scale" in the regulator, that is, the pressure is lower when large amounts are being bled than with small amounts. This scale effect is necessary to secure stability, for otherwise the regulator would not know at what position to come to rest. This is true of reducing valves, as well as of turbine-bleeder regulators; although reducing valves, not being connected to a turbine-governing system, which must have its valves move somewhat slowly to secure electrical stability, are frequently designed to move quickly and then come to rest in a new position at nearly the same pressure. This scale effect of a pressure regulator is analagous to the inherent speed regulation of a turbine, and may be represented as shown in Fig. 5, where the pressure for which the regulator is set is 30 lb. When bleeding 10,000 lb. per hour the pressure is 31 lb., as shown at *A*, and when bleeding 38,000 lb. per hour it is 29.4 lb., as shown at *B*.

The most steam that can be bled by a turbine at any given load is when it is operating with the grid valve closed and passing only the leakage steam to the condenser. It is necessary to pass a small amount of steam to the condenser to cool the low-pressure stages. If the total bled-steam demand is greater than this, it is necessary to pass the balance through a reducing valve.

If we have a constant load of 750 kw. on this turbine, it will be seen from the curve, Fig. 3, that the most steam that can be bled is 42,000 lb. per hour (43,000 lb. to the throttle, 1,000 lb. to the condenser). If, with this constant load, the bled steam demand varies between the limits of 30,000 lb. per hour and 55,000 lb. per hour, it will at times be necessary to take 13,000 lb. per hour through the reducing valve. The reducing valve can either be set "higher" than the turbine bleeder mechanism, so that the fluctuations in demand are shared by

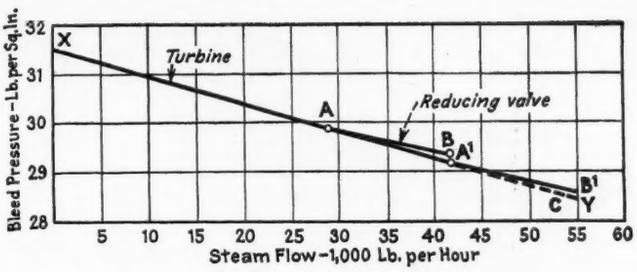


Fig. 6—Bleeder pressure characteristic for turbine and reducing valve combined

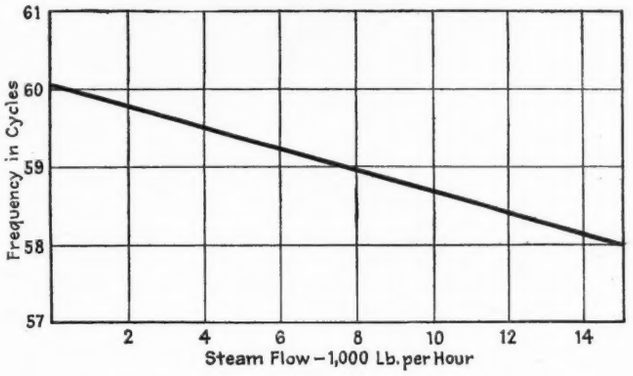


Fig. 7—Speed regulation for compensated bleeder turbine

the turbine and reducing valve, or can be set "lower," so that the fluctuations are taken on the regulating valve alone.

When the compensated bleeder control was first used, good frequency regulation of a bleeder turbine operating alone on the line was not secured, if the bled steam demand was greater than the steam required to carry the electrical load, and the reducing valve was set to come in after the turbine bled its maximum. This was due to setting the regulator so that the turbine could be used as a mixed-pressure machine as well as a bleeder, which is seldom necessary. Although this condition is now met with entire satisfaction, the following outline of the performance obtained under the former condition of operation should be of interest to those designing and operating such plants:

If the reducing valve is set "higher" than the turbine valve, closer control of the pressure and of the frequency is obtained. The pressure characteristic is shown on Fig. 6, in which $A\ B$ is the characteristic for the reducing valve.

If the reducing valve is set so as to open *after* the turbine reaches maximum bleeding capacity, its pressure characteristic is that shown at $A^1\ B^1$, instead of $A\ B$, as before. In this case, there is better economy of steam at low bleeder demands, as all the process steam is being taken through the turbine. However, the frequency control is impaired.

It was stated above that with the compensated bleeder control the inherent speed variation with change in bleeder steam at constant load is small. The inherent speed variation for this turbine, where the full load straight-condensing, is carried on 15,000 lb. per hour, would be as shown in Fig. 7. Here the total speed variation corresponds to the demand for steam to carry the rated load, straight-condensing, the additional steam demand for bleeding requirements causing negligible frequency change. The speed variation, straight-condensing, can be changed and is set to give the characteristic necessary for stability on the system, or to operate satisfactorily in parallel with other machines.

Consider the present case, where the unit carries a 750-kw. load and bleeds the maximum of 42,000 lb. per hour, this demand being at point A^1, Fig. 6. During the increase in steam demand of 55,000 lb. per hour (taken care of by the reducing valve with the pressure decreasing from A^1 to B^1) the bleeder control tries to close the grid valve more, which it cannot, and open the high-pressure valves more, which it can, as will be apparent from Fig. 5. The diaphragm and left-hand oil-relay valve control the grid valve, and the relay valve at the right of it actuates the throttle to compensate for changes in bled steam demand.

The amount of opening of the valves is determined by the line $X\ Y$, Fig. 6, at point C, where the pressure is that at the point B^1. The governor will try to admit the increased quantity of steam shown at this point, or 53,000 total, giving 10,000 lb. per hour over that required by the load. What actually happens is that no more steam is admitted: the main governor comes to rest in the same position as before, but at a higher frequency. The amount that the frequency is increased is determined by the inherent regulation curve, Fig. 7, which shows 1.3 cycles for 10,000 lb. per hour.

This difficulty was overcome as the result of experience with the form of control in the field, which led to the change in its setting mentioned above. The design of the control was also changed in some details, and so adjusted that there would be no further movement of the regulator toward the closed position after the grid valve was fully closed. At part load, it requires less opening of the grid valve to carry the load non-bleeding, than when carrying full load; therefore, the pressure is the same at any load, when bleeding the maximum, but the zero bleeding demand is reached at a higher pressure at light load than at heavy load. It is now possible to set the reducing valve as shown at $A^1\ B^1$, Fig. 6, without disturbing the frequency regulation of the turbine. Thus, we can attain the most economical arrangement of obtaining the low-pressure steam, and at the same time not impair the regulation of the electrical frequency.

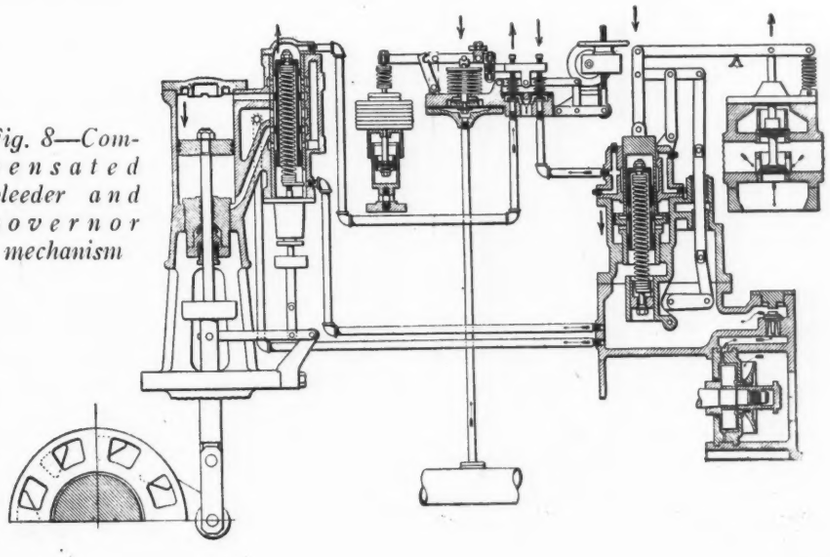


Fig. 8—Compensated bleeder and governor mechanism

The Buckeye DIESEL *Makes Its Appearance*

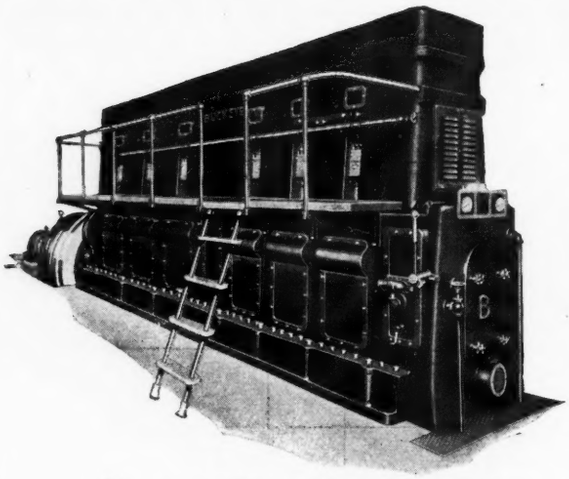
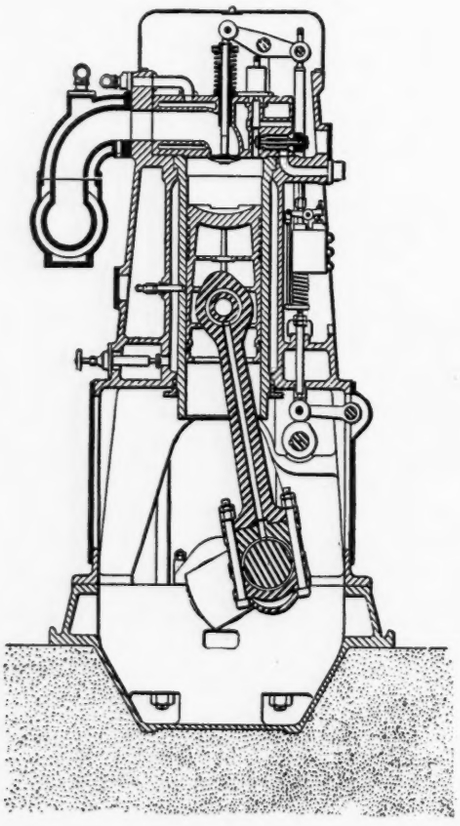


Fig. 1—A 400-hp. six cylinder Buckeye Diesel

A FOUR-STROKE-CYCLE mechanical-injection Diesel has been brought out by the Buckeye Machine Company, Lima, Ohio, in capacities from 200 to 400 hp. This firm has been building a horizontal two-stroke-cycle semi-Diesel for some fifteen years, but found that, while this engine is excellent for work where speed control need not be close and horsepower requirements are low, a vertical multi-cylinder engine with a better fuel consumption and closer speed regulation would meet requirements more adequately. That the company adopted the four-stroke-cycle principle for this new Diesel is regarded by many as highly significant in indicating the trend in American engine design.

The mechanical-injection engine has been the subject of so much research that the present-day designer can hardly evolve anything new in principle, but must depend upon a recombination of proved mechanical movements. The Buckeye designer has evidently proceeded along this line, and has not hesitated to produce a design that incorporates in it various elements that have proved highly satisfactory elsewhere. One detail is new, however, that being the air intake, which is designed to give a highly turbulent cylinder charge.

Fig. 2—Cross-section of the engine showing the accessibility of the parts



The engine is made up of a cast-iron base carrying the crankshaft bearings, and upon this bed is the enbloc frame into which the cylinder liners are inserted. The frame is carried up above the level of the liner top to form an inclosure for the cylinder heads and valve gearing.

The frame is designed to give a comparatively narrow water jacket cavity, and the space between the jacket and outer wall serves as the suction-air compartment, the air entering at each end of the frame through louvers and filters. This design eliminates the "piano" effect, or transmission of the cylinder noise to the outer frame, an objectionable feature of many Diesels.

The air enters the cylinder head through two passages set at 90 deg. This gives a whirling motion to the air as it passes through the admission valve, and eliminates the need of any device to give turbulence.

It will be noticed that the cylinder head can be removed with but a small amount of trouble. The pistons are of the trunk type, with the piston pin set considerably below the center of the body. The crown is concave, so that at the end of compression stroke the air charge is crowded into a compact mass immediately below the fuel nozzle. The piston is 13 in. diameter and has an 18-in. stroke, which permits a rating of 65 hp. per cylinder at 277 revolutions per minute.

As in case of most Diesels, the Buckeye is provided with an individual fuel-injection pump for each cylinder. The pumps are placed in recesses in the frame alongside the cylinders served. This makes the pump more accessible than if mounted on a single block, and permits the use of oil piping of a uniform length, thus insuring that each system has the same pipe expansion and hydraulic characteristics.

Each pump is made up of a simple steel forging into which are pressed the bushings for the valves and plunger. The pump action is shown in Fig. 3. The plunger is given a constant stroke by a cam mounted on a shaft, chain-driven from the crankshaft. The point

of fuel injection is constant at all loads, while the duration is controlled by a bypass valve connected by a linkage to the governor layshaft, which runs along the frame. The governor is of the simple flyball type, mounted vertically in the crankcase at one end of the engine and driven from the crankshaft by helical gears.

The fuel pump, Fig. 3, is an improvement over the one first used, shown on the engine in Fig. 2. No packing is used on the pump plunger, the latter being lapped to fit its bushing. The portion that seals the plunger is outside of the pump body, so that it does not become distorted by the interior oil pressure.

The fuel nozzle is of simple design, consisting of a spring-loaded mushroom valve that admits the oil into the single-hole orifice. The air turbulence is depended upon to give a satisfactory air-fuel mixture, so no attempt is made to produce a finely atomized spray.

In certain details the engine is a marked advance over the usual design. Mention has been made of the

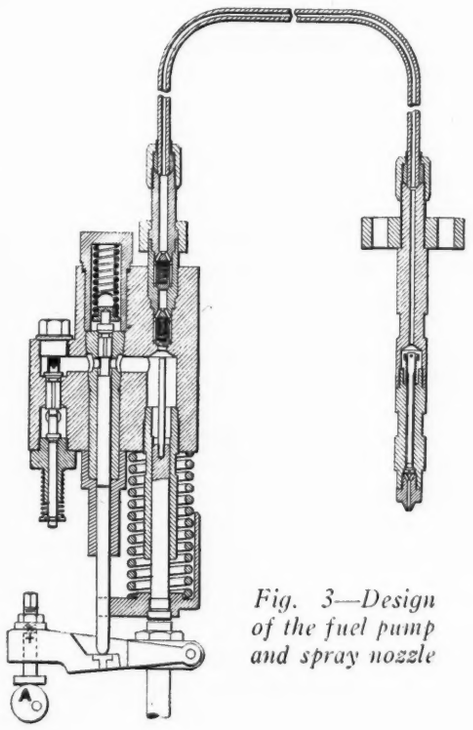


Fig. 3—Design of the fuel pump and spray nozzle

air filters, usually an appendage, but here an inherent part of the engine. Similarly, the engine is provided with built-in fuel-oil and lubricating-oil filters. These are placed in the chamber formed by the frame and the cylinder head dust cover.

The pump for delivering the fuel oil from the service tank to the filter is a reciprocating unit, located at one end of the base and driven from the crankshaft by an eccentric.

A CORRECTION—In the Dec. 17 issue of *Power* it was announced that the first prize at the Annual Meeting of the American Society of Refrigerating Engineers was awarded for a paper on "The Flow of Superheated Ammonia," by J. C. Reed. This was an error. The paper was written and presented jointly by J. C. Reed and E. E. Ambrosius, both students at the University of Illinois.

Care *and* Lubrication *of* Wire Rope

By J. M. Jordan
Donalsonville, Ga.

CARE OF WIRE ROPE should begin the moment it is delivered. When a consignment arrives, do not throw the reels from the delivery truck or car and allow them to fall upon the earth or floor, for in so doing, the reels may be broken and the rope crushed or bruised. Injury to the rope may develop trouble later in service. When rope is unreeled it should not be allowed to kink. This can be prevented by mounting the reel in a revolving position and unreeling by carrying the outer end of the coil away from the reel as fast as the rope comes off.

In rope applications, excessive fleet angle frequently causes trouble, especially in mine hoisting. Fleet angle means that angle of the rope with a line extending from the mid-circumference of the drum to the mid-circumference of the sheave and another extending between the mid-circumference of the sheave and each end of the drum. With grooved drums, this angle should not exceed 2 deg., and for smooth drums it should not be more than $1\frac{1}{2}$ deg. Angles greater than these will tend to cause the rope to climb on the drum when approaching the limits of travel. A pinching and grinding accompanies this riding of the rope, with possibly an abrasion against the head sheave.

LARGE sheaves are favorable for long rope life. Binding the rope between sheave flanges should not be allowed. For ropes $\frac{1}{2}$ in. and less in diameter, use sheaves grooved approximately $\frac{1}{32}$ in. larger. When the rope is larger than $\frac{1}{2}$ in. and less than $1\frac{1}{4}$ in. in diameter the sheave grooves should be $\frac{1}{16}$ in. larger than the rope; $\frac{3}{32}$ in. larger for ropes between $1\frac{1}{4}$ and 2 in. diameter; and $\frac{1}{8}$ in. for all ropes larger than 2 in. The sheave grooves should not be small enough to cause the rope to bind between the flanges, yet not too large to properly support the sides of the rope under load stresses.

When passing around sheaves or drums, wire rope is subjected to bending stresses, and the shorter the bend the greater these stresses are. High bending stresses are probably the cause of more wire-rope fractures than anything else. In some instances the severity of the bending stresses with small sheaves exceeds the load.

Corrugations or scoring in the rope tread of sheaves or drums should be removed by turning in a lathe; otherwise the sharp edges will cause excessive wear and abrasion. Proper alignment of drums and sheaves is essential to long rope life. Worn edges of their flanges is an indication of misalignment of sheaves. When the flanges wear the ropes must also wear.

Wire rope is usually built up on a hemp center. Lubrication of this core is essential to maintaining flexibility and to protecting the internal surfaces of the strands from corrosion and rust. A further benefit of lubricant is preservation of the core fibers.

The hemp core acts as a cushioning for the inner faces of the strands and serves as storage for a lubricant supply. When a rope bends, the hemp core is compressed by the strands, which squeeze out the lubricant from the

core and into or among the strands at the point of greatest need. When a core has been repeatedly compressed, it eventually yields up a large part of the lubricant stored in it.

When a rope's core lacks lubricant it absorbs moisture and deteriorates much more rapidly than when well lubricated, which affects the wearing qualities and life of the rope. New wire-rope cores contain an appreciable amount of lubricant applied during manufacture, but to insure minimum wear between strands and core the supply must be replenished periodically.

WORK done by the rope must be considered when selecting a lubricant for it. The lubricant should be free from alkalies or acids or other substances that might cause pitting and corrosion of the strands. It should also be capable of ready penetration through the spaces between the strands and into the core. The lubricant film should be readily self-spreading and it should be highly adhesive and have a strong affinity for the wire when subjected to heavy rubbing between the rope and other objects. It should retain its viscosity through prolonged exposure, not being affected by corrosive gases or moisture.

For dredges, derricks, steam shovels and cranes, where low speeds are maintained, a heavy-body lubricant of ample adhesive characteristics and applied cold is satisfactory. A straight petroleum oil having a viscosity of around 1,000 sec. at 210 deg. F. applied hot, will give good service. For high-speed hoisting ropes used on mine hoists a lubricant of relatively low viscosity is recommended and one that also possesses good penetrating qualities to saturate the rope well and yet is adhesive. When automatic lubrication is used a light oil having a viscosity of 400 to 500 sec. at 100 deg. gives good service. For brush applications the lubricant should be even lighter.

On light-duty ropes a mineral oil of 400 to 500 sec. viscosity at 210 deg. is recommended, while for heavy haulage, such as logging ropes, coal-mine shaft and slope ropes, derrick falls and furnace hoists a mineral lubricant of a viscosity of from 500 to 800 sec. at 210 deg. should be used. For stationary service, where the rope is exposed to corrosive fumes or moisture, either an oil or grease will do if it adheres sufficiently to the rope under all conditions. A straight petroleum oil with a viscosity of around 1,000 sec. at 210 deg. (the same grade as recommended for low-speed ropes), is satisfactory.

In every case the viscosity should be such that the lubricant will cover the rope and penetrate thoroughly, but not thin enough to run off. Tar products are not good lubricants for rope. They are not entirely waterproof and frequently contain acids that will corrode the wire, more particularly when associated with moisture. Also tar products may be crystallized by exposure and flake off the strands. The higher the speed of a rope the lower should be the viscosity of the lubricant. Greases, although capable of the same consistency as the majority of straight mineral oil lubricants for wire rope, in most cases they do not possess as high adhesive qualities.

A thick semi-plastic lubricant should be used whenever conditions permit (applied in a thinned condition), in preference to a more fluid product in a cold state. Crude oils are, in most cases, detrimental to both rope and core; therefore they should never be used to lubricate wire rope. If the rope is subject to excessive abrasive conditions, the lubricant should be capable of good surface protection, not sacrificing penetrating ability, lubricating and adhesive qualities.

Judicious application of a lubricant is almost as important as selection. Applying the lubricant hot will increase its penetration, and when cooled it will exist as a plastic filler to lubricate the strands and preserve the interior of the rope. This is most easily accomplished by passing the rope through a bath of heated oil. Placing a drum of lubricant that has been heated with a steam coil over the rope and allowing it to run out on the rope is wasteful. This method may be practiced in the absence of facilities for submerging by placing a brush in adjustable contact with the rope, with the bristles upward under the stream of lubricant.

Hand application of lubricant to wire rope is unsatisfactory; but when it must be done a good way is to use a piece of sheepskin and fold or roll it, with the wool coat on the inner side of the roll. Then thoroughly saturate the wool with lubricant and hold it around the rope, running it slowly for safety. This method may be employed on inclined or vertical ropes, while the lubricant can be applied to horizontal ropes by pouring from a dipper, placing a receptacle underneath to catch the excess. Common waste may be substituted for the sheepskin, but the latter is better. Another method consists of passing the rope through a V-shaped wooden trough on the earth or floor, pouring the lubricant on with a dipper and catching the excess with a waste swab held near the end of the trough.

The ideal method of application is an arrangement by which the rope is passed through an oil bath, with the latter positioned to facilitate the application without removing the rope from service. Where frequent lubrication is necessary, it is best to provide the oil bath in some practical manner.

SERVICE CONDITIONS in each case should control the frequency of lubrication. Applications are not necessary as long as the crevices between the strands show evidence of ample lubricant and the rope remains in a satisfactory condition. Frequency of application should be increased with an increase in the number of short bends, heavy duty, and deteriorating characteristics of the surrounding atmosphere.

If wire rope is stored, give it a good application of lubricant just before doing so. There is no more reason for expecting a wire rope to continue to function satisfactorily without lubrication than there would be for requiring a steam engine to run without oil.

Australian Claims He Can Harness the Waves

AN ENGINEER of Sydney, Australia, P. A. C. Bates, claims to have solved the problem of producing power on a commercial scale from sea water.

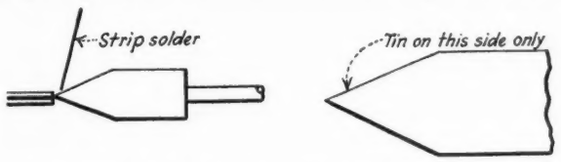
Mr. Bates has installed a mechanical device at Lurline Bay, New South Wales, for practical demonstration. The waves rushing in and out of a specially made channel in the rocks operate floats on pontoons, which in turn operate powerful pumps. These pumps force water at high pressure into accumulators equipped with safety valves and pressure gages. From the accumulators the water passes at regulated pressure to water turbines, which may be coupled to electric generators to produce power and light.

Right Out of the Plant

Pointers on Soldering Electrical Apparatus

SOLDERS for electrical apparatus are generally in strip or in wire shape to facilitate their use. On many occasions it is necessary to hold the soldering iron in a nearly horizontal position. In such cases only the upper side at the edge of the soldering iron should be tinned (as shown in the sketch), since this results in a considerable saving in solder, time and labor.

When both sides are tinned, the solder tends to run through the space between the soldering iron and the



For certain work the iron should be tinned on the upper side only

metal part. The amount of the solder thus dropped is usually much greater than that which flows into the joint. Although the floor spillings can be remelted, they are dirty and there is danger of getting them contaminated with other metals, considerably reducing their value.

By tinning the upper side of the soldering iron only, the solder flows first into the joint and later superfluous solder drops to the floor. It is evident that a saving not only in solder but also in time and labor is thus effected.

Chicago, Ill. JAMES SILBERSTEIN.

Increasing the Load on Low-Pressure Cylinder of Compound Engine

THIS is in answer to an article in the "Right Out of the Plant" section of the Dec. 10, 1929, number of *Power* by Charles J. Mason, in which he disagrees with the statement in a letter in the Nov. 12 number that increasing the cut-off on the high-pressure cylinder of a cross-compound corliss engine would cause the low-pressure cylinder to carry a greater load in relation to the high-pressure and recommends that the low-pressure cut-off be made earlier to achieve the result.

What is the difference? Either one causes a higher receiver pressure, which is the desired condition for causing the low-pressure to carry a greater share of the load.

Mr. Mason says that making the high-pressure cut-off later causes the engine as a whole to carry more load. The governor takes care of that. Consider an engine with a constant unchangeable load. Suppose the high-pressure cut-off to be lengthened and the low-pressure left alone. More steam is used in the high-pressure cylinder, and this in turn builds up the receiver pressure, which causes a greater mean pressure in the low-pressure cylinder, developing more power. As the mean pressure in the high-pressure cylinder increases, the steam usage only is increased and no more power developed, as the back pressure increased with the mean pressure and offset it. These are the immediate results. The high-pressure cylinder is putting out the same power and the low-pressure cylinder more power than before, and as the load is constant the engine must attempt to speed up. The governor then causes an earlier cut-off on both cylinders, to maintain the proper speed, but this would not appreciably change the relation between the work done by the cylinders.

Although changing the high-pressure cut-off and not the low-pressure achieves the desired results, it is not common, nor, I believe, good practice. The high-pressure cut-off should be set to the manufacturer's specifications, and changes made on the low-pressure where provisions are made for it—usually with a screw and hand-wheel or milled nut. RAYMOND F. BENNETT.

Middletown, Ohio

Serious Air-Receiver Explosion

AS MOST ENGINEERS or power plant operators have to do with air compressors of various sizes, operated under widely varying conditions, the following account of an air-receiver explosion at an oil service station at Rensselaer, N. Y., on Dec. 23, 1929, may be of interest. Three men were killed in the explosion, which was immediately followed by a fire. Another man was burned. He stated that just previous to the explosion he heard a hissing noise.

The plant consisted of three 10,000-gal. oil tanks of the cylindrical-horizontal type, and three 72,000-gal. oil tanks of the vertical-cylindrical type, and a filling station and a building containing oils in drums and barrels.

The force of the explosion was felt for ten miles. The plant was completely wrecked, but none of the bulk oil tanks exploded, although they were shocked sufficiently to leak oil, which fed the fire. The roof of a building housing lubricating oil was destroyed and a heavy I-beam used as an overhead monorail track was thrown a great distance.

An investigation disclosed no evidence that any of the bulk oil tanks were the cause of the explosion. However, an air receiver showed every evidence of being the cause. The vessel was about 18 in. in diameter and 54 in. in length. The type of longitudinal joint could not be determined. One head had torn loose part way around. The head was flanged with a skirt about 1½ in. deep, the turn of the flange being sharp and with practically no fillet on the inside. The head had been joined to the shell by welding, but the shell had not been flanged down over the turn of the head. The head, which had not blown out, showed several slugs of brass at the weld. This inclines me to believe that it had been sweated in with brazing or had been welded with brass rod and not with rod of the same characteristic as the parent metal.

The tank partly collapsed at the end where the head had blown out, but whether this had been caused by the heat of the fire or was due to partial vacuum created following the outrush of the gases was impossible to determine. The head was distorted but not torn. The shell plate was shattered in two places, a circumferential tear extending about 15 in. and located about 1½ in. from the end of the cylinder. From the center of this

there was a tear in a longitudinal direction to the edge of the cylinder. Another tear, also in a circumferential direction, on the opposite side of the shell, about 1½ in. from the edge, was about 10 in. long. Both occurred at a point directly over the edge of the flange.

There was no evidence of a safety valve on the tank or of an oil drain connection. The compressor was a small belted unit with a fly-wheel fan and was fitted with two small relief valves. The valves did not have pull levers.

Apparently, the receiver was set in a building in which oil was handled. It is very probable that the air compressor had drawn in oily dust and fumes from the atmosphere. It is also probable that, as these were heated in course of compression and subsequent cooling, there was some precipitation of inflammable substance within the receiver, which, in the course of time, either due to lack of cooling water or to failure of the pressure switch to the motor, caused a high enough temperature to exceed the flash point of the contents. There is also the possibility that the force of the explosion may have disturbed oil-impregnated dust to an extent to make it ignitable coincident with explosion.

There is little doubt in my mind that the explosion was due to ignition of inflamable gases under compression within the receiver. I had an air tank catch fire from this cause about 15 years ago. Only for the fact that the tank, which was not much larger than the one in this instance, was equipped with a 2-in. safety valve, there would no doubt have been a serious explosion.

Owing to lack of legislation in all except a few states and independent cities, and owing to the general lack of knowledge as to the hazards involved with air tanks, it is surprising that there are not more accidents of this nature.

Air receivers should be equipped with safety valves of the spring pop, pull-lever type, also with an oil drain. Placing dependence on a compressor relief valve and a motor cut-out switch is not enough. This accident illustrates the danger of welded pressure vessels where the design is poor or the character of the workmanship doubtful. I am of the opinion that in the welding of the heads the base metal was subjected to heat abuse. The fact that the shell tore in a circumferential direction, where the strain is only half that of a longitudinal direction, and to the fact that the tear paralleled the welding tends to support that view. FRANK L. GILLMOR.

Albany, N. Y.

Preventing Armature Bands From Heating

IN THE Nov. 12 number of *Power* a question is asked about the cause of armature bands heating in a newly wound direct-current dynamo. The eight copper clips on the steel-wire bands act as conductors in a magnetic field and have a voltage generated in them. The steel-wire bands form short circuits of the voltage in any two copper clips under the influence of two opposite poles. This causes a current to flow in the bands and heats them to such an extent that the solder is melted and thrown out.

To eliminate the heating, remove all the clips except the one at the beginning and ending of each wire band. This clip is soldered to the band and the band is soldered at about seven other places equally spaced around the armature. M. M. VYAS, *Chief Engineer*,

Ahmedabad, India. The Maneklal Harilal Mills.

How to Construct Steam-Air Jets to Reduce Smoke

STEAM air jets, induction tubes or steam jets, are often used as an aid to smokeless combustion. They blow air over the fuel bed so as to produce turbulence and help burn the unconsumed volatile gases and smoke from the coal. The most efficient type of steam air jet is that used in a gas producer, Fig. 1. These blowers are made in large sizes and considerable work has been done to bring them up to their present high efficiency.

From a study of Fig. 1, the following design characteristics are noted:

1. The steam nozzle is about four throat diameters away from the throat at the induction tube.

2. The induction tube has a funnel shaped entrance of about 23-deg. included angle and of a length about equal to the throat diameter.

3. The induction tube discharge pipe expands with a 7-deg. included angle and has a length of three times the throat diameter.

4. The steam nozzle has a curved entrance and an expanding outlet of 7-deg. included angle.

There is a great difference between these large efficient blowers and the small home-made smoke consumers. Incidentally, many of the patent smoke consumers are not as good as some of the home-made ones. It would be impractical to adopt the design of the large blowers to the small steam-air jet smoke consumer, but many of the fundamental principles can be incorporated in any steam-air jet with good advantage.

The April 10, 1928, number of *Power* contained an article by H. K. Kugel, giving the results of experimental work on steam jets, in which he stated that their efficiency is increased by having the steam nozzle outside the induction tube and also by having a rounded entrance to the induction tube. Since this article was written, additional experimental work has been done and a number of improved practical installations have been made.

The amount of steam discharged per minute can be computed from Napier's formula. Following is a table for various size orifices and different steam pressures:

SATURATED STEAM DISCHARGED THROUGH NOZZLES
(Pounds per minute)

Diameter at Smallest Section, In.	Steam Pressure, Lb. per Sq.In., Gage												
	40	50	60	70	80	90	100	110	115	125	150	175	200
1/16	0.15	0.17	0.2	0.22	0.25	0.27	0.32	0.32	0.35	0.37	0.43	0.5	0.56
3/32	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	1.0	1.1	1.3
1/8	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.7	2.0	2.3
5/32	0.9	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.2	2.3	2.7	3.1	3.5
3/16	1.3	1.6	1.8	2.0	2.2	2.5	2.7	3.0	3.1	3.3	3.9	4.5	5.1

It is seen that considerable steam is used by the steam-air jets. In most installations, the jets are used only a small portion of the time. The net result can be computed only by a boiler test to show the increased efficiency attained from more perfect combustion.

On a hand-fired boiler it is desirable to stop the steam-air jets after the first volatile gases have been driven off. This usually requires from 3 to 5 min. To reduce the human element of forgetfulness, it is advisable to have a quick-opening steam valve so connected to the fire door that the opening of the fire door will start the steam-air jets. The valve should be placed at the top of the steam jet line, to eliminate the water pocket above the valve. The quick-opening valve is closed by hand after a few minutes.

Fig. 2 shows an improved form of door-opening

steam-air jet as applied to a vertical boiler such as is used on a locomotive crane. The combustion tube rolled into the water leg is a 2-in. boiler tube. The mixer is a 1¾-in. boiler tube. A ⅜-in. tee is brazed as shown. The nipples and ells are ¼ in., and the orifice is a $\frac{3}{32}$-in. hole drilled in a ¼-in. brass plug. The steam-air mixer increases the efficiency, and the door-opening device reduces the possibility of neglecting to use the jets when they are needed. The boiler tube is easy to flare to a funnel by driving a tube heated at one end onto the tang of an anvil, turning the tube slightly after each blow.

Fig. 3 shows a steam-air jet made of a 2-in. pipe, 3 to 2 in. reducing coupling and standard ¼-in. fittings. A sheet copper or steel funnel wrapped inside the reducer and brazed in place makes a great improvement by reducing eddy currents. The nozzle, or jet, is a brass plug drilled with a $\frac{3}{32}$-in. taper at the outer end. Steam-air jets as shown in Fig. 3 are often used in brick-set boilers. The jets should be about 12 in. apart and should be set as low as possible above the fire doors. They should point to the bridge wall about 12 in. above the grate. The advantage of this design is that the parts can be bought at any pipe shop, welded at a job welding shop and then are ready for the pipe-fitter to assemble and install. The $\frac{3}{32}$-in. orifice in the brass plug can be drilled by hand.

Fig. 4 shows a practical installation of door-opening steam-air jets on a Scotch boiler. The furnace flues are 42 in. in diameter. Two 2½-in. boiler tubes flared funnel shape at one end are used in each furnace. The steam nozzle, Fig. 5, is a ⅛-in. brass plug drilled with a $\frac{3}{32}$-in. orifice and threaded into the side of a ¾-in. extra heavy steel pipe (which acts as a manifold for the two jets). The manifold is clamped in place an inch away from the outer end of the funnel. The 2½-in. flared boiler tubes are spaced 12 in. apart and point to the bridge wall and above the grates. The door-opening mechanism is shown, as well as the location of the quick-opening steam valve at the top of the steam line.

E. L. LANNERT.

Cleveland, Ohio.

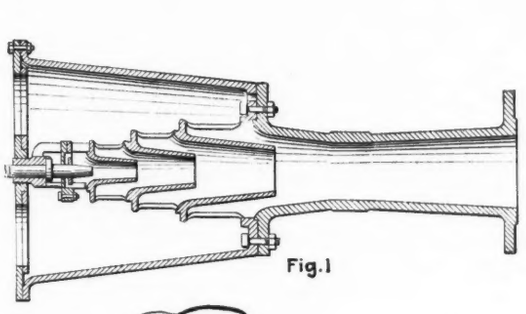


Fig. 1

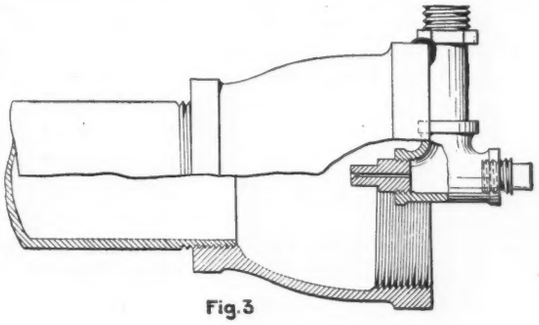


Fig. 3

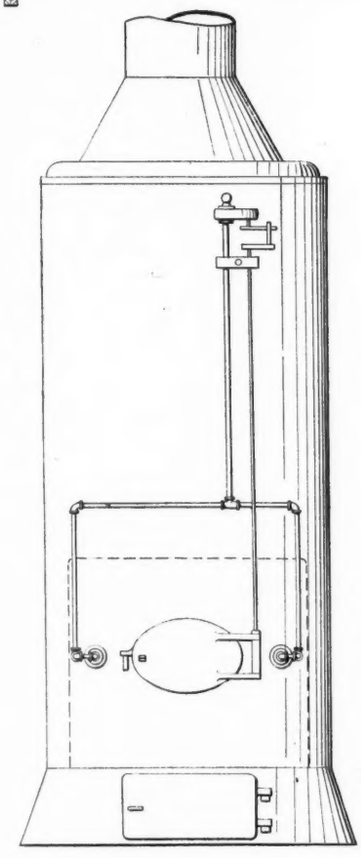


Fig. 2

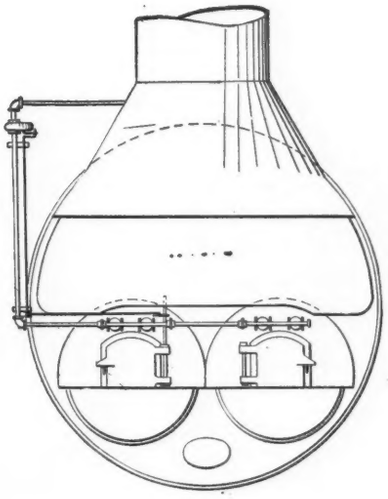


Fig. 4

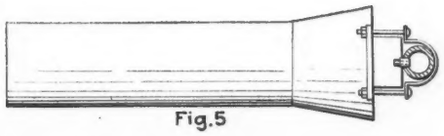


Fig. 5

Details of steam-air jets and methods of installation

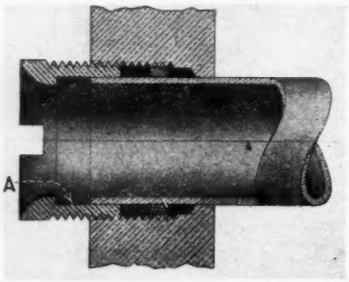
[At the fuels meeting of the American Society of Mechanical Engineers in Philadelphia, Mr. Lannert said he did not approve of steam-air jets as a cure-all for the smoke problem, but that there are some boilers where they seem to be the only available way of reducing the smoke. In his work as Deputy Smoke Commissioner in Cleveland, Mr. Lannert has gained considerable experience with steam jets. The foregoing comments are based on practical installations.—THE EDITOR.]

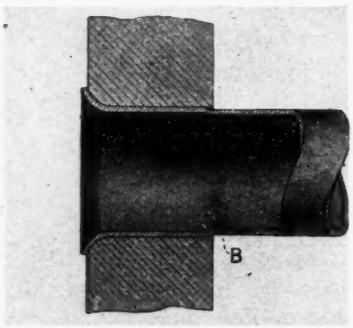
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Improved Method of Installing Condenser Tubes

AMONG the many factors affecting the life of condenser tubes, general corrosion is probably the most common, and can usually be attributed to one or a combination of causes. It is generally conceded that the entrained and dissolved air in the circulating water is responsible for much of the corrosive action. It is also generally accepted that the ferrule, as usually installed, is an important contributing factor to tube deterioration, owing to the gas pockets formed in the space between the shoulder in the ferrule and tube end, as at *A* in Fig. 1.



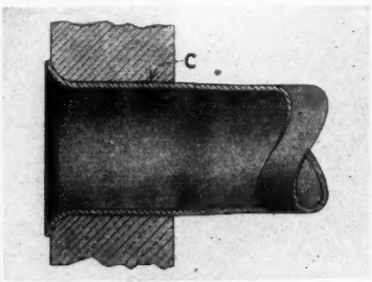


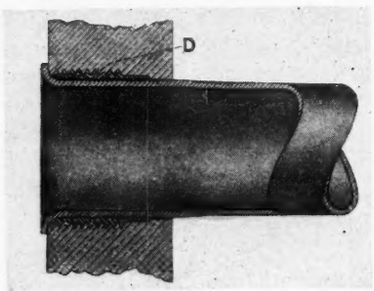
Figs. 1 and 2—Usual methods of installing condenser tubes with ferrule and packing and by expanding

Several ways to overcome this action, or to eliminate the gas pockets, have been developed, including the use of special entrance nozzles and the more common one of expanding the tubes in the tube sheet and flaring the ends as shown in Fig. 2. The latter method, although doing away with the ferrule, introduced new troubles through improper expanding of the tubes, resulting, in many cases, in reduced thickness of the tube and also producing a distinct shoulder on the inside of the tube at the end of the expander rolls.

With a view to eliminating these various troubles, the Scovill Manufacturing Company, Waterbury, Conn., has introduced the improved method of installing condenser tubes illustrated.

A method which removes the necessity for over-expanding and gives increased holding power, as well as eliminating creep of the tube in the sheet, is shown in Fig. 3. A special tap is first put through the hole in the sheet to give a series of grooves 0.005 in. deep (as at *C*) (about forty per inch) into which the tube is forced by expanding. After expanding, the end of the tube projecting beyond the tube sheet is belled over. The expanding is done with a tool having long rolls and tapered ends, so that the tube is expanded the full thickness of the sheet and has an easy taper to meet the normal internal diameter of the tube.





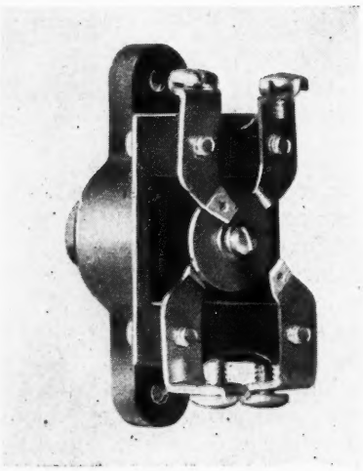
Figs. 3 and 4—Improved method of installation on new and existing condensers

To adapt this method to existing condensers, on which the tube sheets have been drilled and tapped for packing in the usual way (with packing and ferrules), the bushing *D* is first screwed in to fill the space normally occupied by the ferrule. It is then faced off and countersunk with a radius tool, and the special tap is run through to give a grooved surface, as previously described. After it has been rolled in the sheet the tube is flared or bell-mouthed to give a proper hydraulic inlet to the circulating water, then beaded over against the tube sheet to avoid any disturbance in the flow and to present as nearly as possible a smooth sheet.

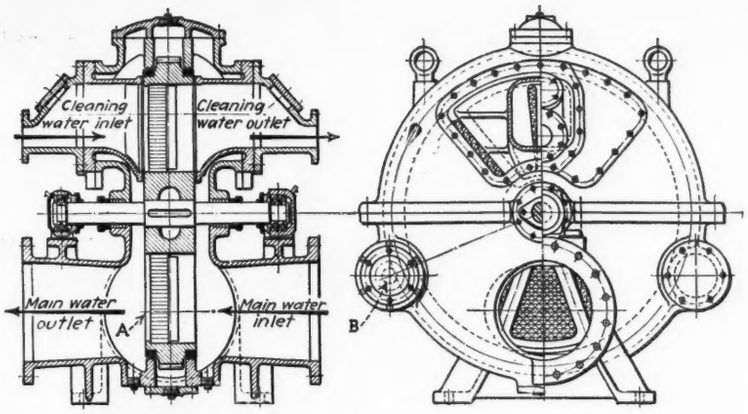
New Push-Button Units

A NEW push-button unit is being offered by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., for use with elevators, conveyors, and in other applications where a control station is desired as a built-in unit. Compactness combined with the ease of mounting, flexibility of arrangement and time saved in wiring make the unit practical for industrial control applications.

The frame of the push-button, on which the mechanism is mounted, is of black micarta, and the operating button can be furnished in either black or red.



Rear view of the unit



Section and side view of rotrex strainer

Rotary Strainer With Continuous Cleaning

ONE OF the essential requirements of a strainer designed for use on the suction lines to pumps and other pipe lines that must be kept in continuous service is that some means be provided for cleaning the strainer without taking it out of service or stopping the flow of water through it.

The rotary strainer illustrated, now being put out by the Andale Company, 1600 Arch St., Philadelphia, Pa., is a type of strainer that meets this requirement and is particularly suitable for use on lines where the percentage of foreign matter in the water is high.

The unit consists, essentially, of a stationary casing and a rotating strainer wheel having teeth on its periphery which engage with a driving pinion, the pinion in turn being driven by a motor through a reduction gear or V-belt, as best meets the requirements. The inlet side of the strainer wheel has a series of spokes or webs to hold the leaves, grass and other foreign matter and carry it, as the wheel rotates, to the top of the casing, where it is washed free by a cleaning water jet and discharged through a refuse pipe. The water jet, or orifice, is made the full height of the strainer section, but is rather narrow, so that full pressure is maintained in the cleaning chamber and a comparatively small pipe line will supply the necessary water for this service. The strainer wheel shaft and the pinion shaft are mounted on ball bearings. The casing is split horizontally, the bottom half carrying the main water connections and the bearings for the strainer wheel shaft, and the upper half the backwash water connections, as shown in the illustration.

Four different driving positions are possible, as the wheel casing has a pinion housing on each side and the pinion is reversible and may be driven from either side.

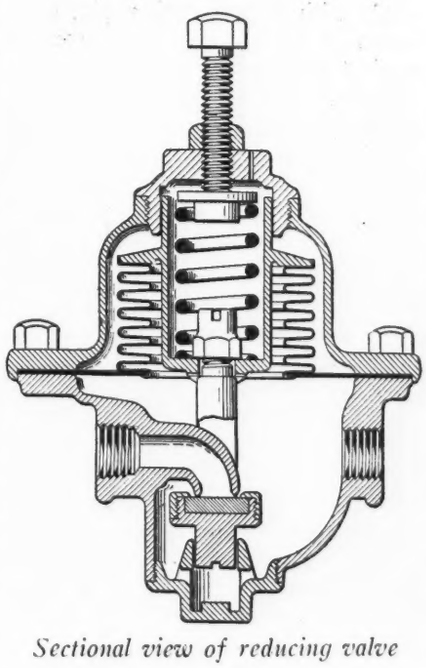
Made in six sizes or frames, Nos. 1 to 6, inclusive, units are available in capacities from 4,000 to 70,000 g.p.m. and with pipe connections from 14 to 60 in. in diameter.

Bellows Pressure-Reducing Valve

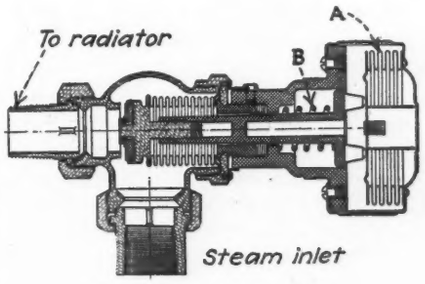
EMPLOYMENT of a bellows in place of the standard flat metal diaphragm to amplify the pressure variations and thus obtain full port opening with greater capacity and increased sensitivity is a feature of the new pressure-reducing valve (No. 368) put out by the Mason Regulator Company, 1190 Adams St., Boston, Mass.

Of all-bronze construction (except the rustproof steel spring and cap screws, and with special composition disk) the valve is particularly suitable for use with any gas or liquid. The spring is inclosed in a waterproof housing and adjustment for any desired variation in pressure is made by means of a screw in the top of the valve. The valve disk is carried from a yoke attached to the spring housing and is drawn upward against the seat by the pressure exerted on the bellows and spring chamber, this upward pressure being opposed by the spring.

A removable plug at the top permits spring replacement without removing the valve from the line or breaking a pressure joint, and a plug at the bottom likewise permits ready replacement of the valve disk. The replaceable composition disk is selected to meet the requirements of the service on which the valve is to be used. The valve is available in all standard pipe sizes from $\frac{1}{4}$ to 2 in. inclusive.



Sectional view of reducing valve

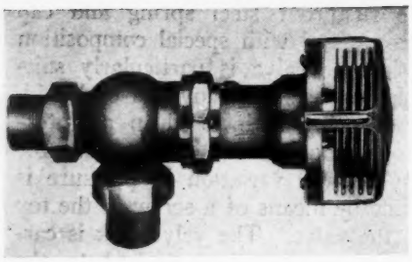


Cross-section of valve

Automatic Radiator Valve

AN AUTOMATIC RADIATOR VALVE in which is combined a packless valve and temperature control unit has recently been added to the line of automatic control valves put out by the Fulton Sylphon Company, Knoxville, Tenn. The valve is suitable for any two-pipe steam-heating system utilizing either floor or ceiling radiators. It operates automatically when there is a variation in the room temperature and regulates the flow of steam to the radiator to which it is attached.

Referring to the cross-section, the thermostatic element employs the standard Sylphon bellows, which functions to close the valve or permits it to open in accordance with the heating requirements of the room. A second bellows is connected between the valve disk and bonnet to form a packless valve, eliminating the usual



Packless radiator valve with temperature-control unit

packing with its consequent friction on the valve stem.

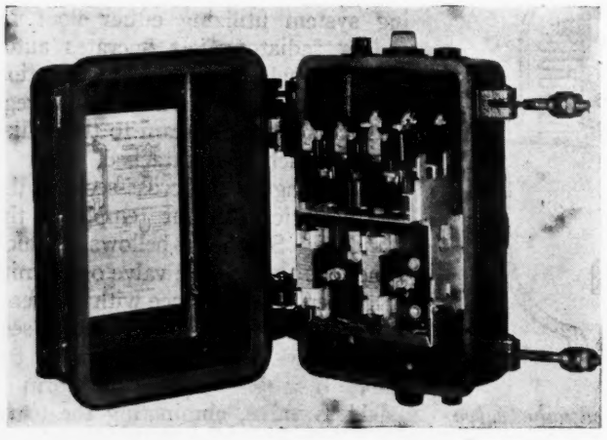
In operation the valve is closed by pressure exerted by the thermal unit or bellows *A*, with an increase in temperature in air surrounding it. This pressure is opposed by the spring *B*, which functions to open the valve again with a release of pressure in the bellows due to a lowering of the temperature. The point at which the valve will open or close is regulated by rotating the thermal unit, which in turn increases or decreases the tension of the spring *B*, the maximum rotation being only a fraction of a revolution. For a permanent setting the thermal element can be locked in position by a setscrew. Unions are provided on the steam and radiator connections to facilitate installation on an existing system.

All parts of the valve are of brass, with nickel finish, except the insulating section between the valve bonnet and the bellows, which is of bakelite. An insulating material is used for this part to prevent the conduction of heat from the valve to the thermostat.

Gas-Tight Inclosures for Motor Starters

A GAS-TIGHT inclosing case for across-the-line motor starters types A-20 and A-30 put out by the Condit Electrical Manufacturing Corporation, Boston, Mass., is illustrated. The case, which is also dust-tight and weatherproof, is of unusually strong cast-iron construction. A gasket is provided between the case and the cover, the latter being hinged and secured in place, when shut, by four heavy eye-bolts and nuts as shown. There are conduit connections at the top and bottom.

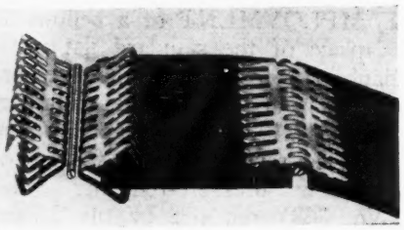
The new inclosing case is particularly suitable for installation in mines, pulverizing plants, chemical plants and other places where a large amount of dust or gas may interfere with the operation of a standard starter. Provision is made for padlocking the cover shut to avoid tampering.



Dust-proof inclosing case for motor starter

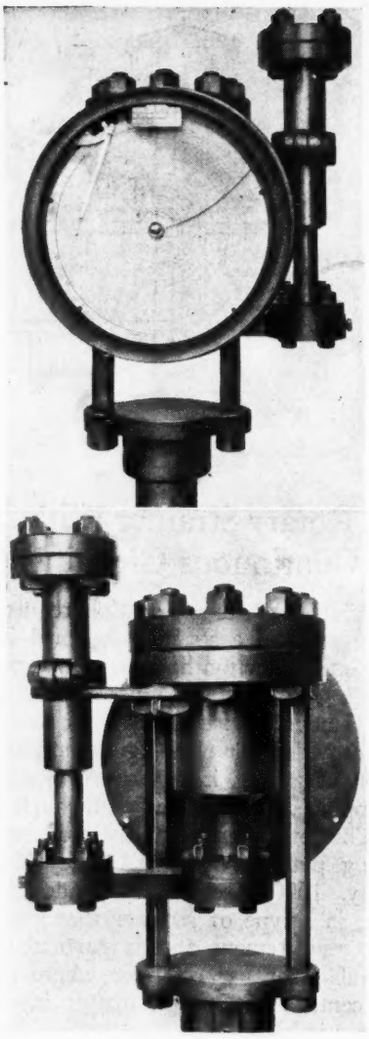
Flexible Steel Belt Lacing

A COMPLETE LINE of flexible belt lacing called "Steelgrip" and made of heat-treated steel has been brought out by Armstrong-Bray & Company, 28 North Clinton St., Chicago, Ill. The joint of the lacing is made with a steel rocker pin, composed of two segments, one rocking against the other.



Belt lacing before and after application to a belt

It may be used for leather, fabric, or composition belts, and may be applied by means of a hammer. It is made for $\frac{3}{16}$- to $\frac{1}{2}$-in. thick belts.



Front and rear views of high-pressure flow meter

High-Pressure Flow Meter

THE increasing use of high pressures has led to the development, by the Foxboro Company, Foxboro, Mass., of a new flow meter suitable for any working pressure up to 5,000 lb. per square inch and for measuring the flow of gas, air, steam, hot oil and gasoline.

In the design of the new meter all the important features of the standard line of orifice meters made by this company have been retained, but all working parts subject to pressure have been made from drop forgings, and every part is specially designed for high-pressure work, as will be apparent from the rear view of the meter shown in the accompanying illustration.

The meter is calibrated to read and record in terms of flow and may be equipped with an integrator that shows directly the total flow in gallons, cubic feet or pounds.

FROM AMONG READERS' PROBLEMS

Conducted by
L. H. MORRISON

LOSS DUE TO STEAM PRESSURE DROP—*A recent piping handbook states that there is no loss when a pressure drop occurs by reason of a small size of pipe. Is this correct?* G. A.

The handbook is rather loose in its statement that there is no loss accompanying a drop of pressure in a steam line.

What the author of this handbook should have said, and probably meant to say, is that there is no heat loss but there is a loss in availability of the heat energy.

This can be easily seen if you will assume a boiler operating, let us say, at 400 lb. and a steam turbine being supplied from this particular boiler. If there is no pressure drop between the boiler and the turbine, then the water rate of the steam turbine will be a certain value. If you cause a pressure drop by partly closing the throttle of the turbine, or the valve on the heater between the turbine and the boiler, the water rate per kilowatt-hour of the turbine will steadily increase as the pressure drop in the steam line increases.

Consequently, it is not true that there is no loss or no objection to a loss in the pressure drop between the boiler and the prime mover. There is, of course, an economic size of header where the additional cost of a larger header is just equal to the gain brought about by the decrease in the pressure drop.

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CLEARANCE IN IMPULSE TURBINES—*Does the amount of clearance between the movable blades and the casing of an impulse turbine seriously influence the steam consumption?* O. W. B.

All the pressure drop in an impulse steam turbine takes place in the nozzle and not in the movable blades themselves. Consequently, the pressure on both sides of a wheel is approximately the same, and, therefore, there is little difference in economy when the clearance between the buckets and casing has been increased.

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MEANING OF DEGREE-DAY—*What is meant by the term "degree-day" in heating work?* G. E. J.

It is based on the fact that at 65-deg. outdoor temperature building heating is not generally required. The degree-day, then, is the difference between this temperature and the average daily temperature. Thus, if the mean temperature for a given period, say two days, has been 45 deg., the heating requirement may be expressed as 40-degree-day, and if the period were one day it would be expressed as 20-degree-day.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

WE USE a 125-kva. generator direct connected to a single-valve automatic engine in our laundry. The voltage varies so much that the lights dim, especially when one of the induction motors is thrown on the line. How can this trouble be remedied? C.C.

ASSUMING that the exciter is large enough and the steam line to the engine is large enough to supply sufficient steam, the poor voltage regulation of this generating unit may be due to one of three causes. The speed regulation of the engine may be poor, causing a wide variation when the load changes. The unit may be overloaded, which would cause a wide speed change on the engine and would also cause a voltage drop in the generator. The inherent regulation of the generator may be poor.

If the engine speed changes greatly, it may be that the governor is sticking. If the unit is overloaded, it may be due to a poor power factor, which would cause poor regulation. This can be corrected by either static condensers or, if a synchronous motor installation is practical in any part of the plant, by adjusting the motor to correct the power factor. This would make an operating saving as well as give better performance.

The trouble will most likely be found in the voltage regulation of the generator itself, which can be corrected by the installation of a voltage regulator. In the writer's opinion, a voltage regulator is a necessary part of any alternating-current generating plant, and its installation would go a far way toward remedying the trouble regardless of its cause. If the trouble is engine speed, the voltage regulator will take care of it entirely, and if the trouble is due to overload on the generator, it will give a noticeable correction but possibly will not entirely eliminate it.

A. L. FREULER.
St. Louis, Mo.

IF THE plant was designed by a competent engineer and standard equipment was installed, governor trouble may be looked for.

If the plant is an assembly of second-handed machinery the exciter may be insufficient. Motors of larger capacity than necessary may add to poor service. A slow-speed generator of this size should use at least a 6-kw. compound-wound exciter. The total motors installed should not exceed 125 hp. They should be of small capacity, and those exceeding 15 or 20 hp. should be of slip-ring or wound-rotor type.

F. E. BRODIE,
Brodie Light & Power Co.
Leesville, S. C.

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I HAD an experience similar to the one under discussion and I found the trouble in the automatic governor.

When the load was light, the voltage stayed up, but as soon as an elevator or other motor was put into service the voltage dropped and the engine slowed down. The trouble was in the pins of the governor springs. The grease had hardened and this made the action sluggish. I cleaned out the grooves of the pins so none of the old grease remained. The re-greasing and cleaning put new life in the governor and the voltage remained constant.

H. F. SCHWONBERG.
Cleveland, Ohio.

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WITH the scanty information available, it is difficult to give any reply that will indicate a sure method of remedying the trouble complained of.

In the first place, we have to assume that the speed of the engine does not vary more than would normally be expected with fluctuations in load. Variations in demands for process steam in the laundry might occasionally have the effect of throttling the engine exhaust, and so slowing up the generator. This should be checked, and if necessary corrected by fiting some form of atmospheric relief valve.

It is evident that some, at any rate, of the motors are large in comparison with the size of the generator; the question alludes particularly to one such motor. If the horsepower of the

motor is more than about 20 per cent of the generator capacity, there is sure to be considerable disturbance when starting the motor, and this will be accentuated if the generator is already carrying considerable load. The motor may be of poor design, taking a large magnetizing current, or it may not be of suitable size for the work that it has to do. Again, the motor may have to start under somewhat heavy conditions.

The most probable causes of the trouble are: Overload on the generator, or steam engine; poor power factor, causing poor regulation of the generator; and excessive line drop in conductors. The last is quite likely in a low-voltage installation.

If the machine is overloaded, additional equipment will be necessary. If the generator is overloaded electrically, due to a low power factor, but the engine is not overloaded, the best and cheapest course will be to improve the power factor, either by insuring that no motors are too large for their loads, or by installing corrective equipment.

If the machine is not overloaded electrically, but low power factor is causing poor regulation, this may be corrected either by hand adjustment or, better still, by the use of an automatic voltage regulator. But in this case also, by far the best solution is to correct the power factor, and thus enable the generator to give good regulation.

Excessive voltage drop in conductors can easily be checked. If necessary, additional copper can be installed.

With regard to the big motor that is the particular offender, it might be possible to reduce the disturbance by starting the motor on no load with the lowest compensator that will bring the motor up to speed with certainty. A belt drive with fast and loose pulleys, or a friction clutch of either the automatic centrifugal or the hand-operated type could be used. A slip-ring motor would start the load with much less disturbance to the line than a squirrel-cage motor, and it might pay to make the change.

The questioner would do well to check the efficiency of his electrical plant, following the lines indicated above. If, after making all possible improvements, there is still trouble, he will have to consider additional equipment. If the exhaust from the engine gives ample process steam, it might pay to take a supply of power from the local public utility to make up the deficiency, rather than consider additional engine capacity.

C. E. OLIVE, *Chief Engineer,*
Canadian Celanese, Ltd.
Drummondville, Canada.

NO REFERENCE is made to flickering of the lights, so we may assume that the flywheel is of proper size. It is not stated that the voltage returns to normal, after the induction motor reaches full speed, without attention from the operator, nor is the rating of the induction motor given.

It is probable that an automatic governor controls the speed of the engine. If the power load increases suddenly, as, for example, when an induction motor is started, the governor cannot respond rapidly enough to prevent the speed from momentarily falling below normal. If the engine speed dropped 2 per cent, the generator voltage would probably be reduced approximately 6 per cent due to this cause only. The consequent reduction in illumination would be approximately 20 per cent. This would probably be noticeable, but not objectionable.

The drop in voltage due to the electrical characteristics of the generator is of much greater magnitude, and is probably the voltage drop referred to in the question. When the electrical load is increased, the generated voltage is reduced due to the increased dmagnetizing effect of the extra current, and the difference between the generated voltage and the terminal voltage is increased due to the increased reactance drop. The only method of counteracting this drop in voltage is to increase the excitation by an amount sufficient to neutralize the increased demagnetizing effect and to raise the generated voltage enough to give the original terminal voltage.

When the change in load is small compared to the rating of the generator, the initial drop in voltage is small and although noticeable is not objectionable. Satisfactory operation is possible by increasing the excitation manually. If the change in load is relatively large and the drop in voltage objectionable, then it is necessary to resort to some type of automatic regulator, since manual operation is not fast enough. The proper control to use is a standard automatic generator voltage regulator such as is supplied by the larger manufacturers of electrical equipment. This would maintain the voltage constant under all normal operating conditions, and would eliminate the necessity of manual control. In some cases, where one or two large motors cause the objectionable voltage drop, it is possible to devise a system of relays and resistors, costing less than an automatic generator voltage regulator, that would automatically increase the generator excitation by a definite amount while the large motors are connected to the generator. The design of such a system of relays and resistors requires a knowledge of the characteristics of the generator, of the control, and of the large induction motors.

I have tried to show that the drop in voltage is probably due to the change in load being relatively too large on a generator manually controlled. The objectionable drop can be overcome by decreasing the relative load, that is, by installing more generator capacity; or by the use of an automatic regulator on the generator.

JOHN R. DUNBAR.
Hamilton, Canada.

THE question is a broad one, with little information regarding the electrical characteristics. However, it is certain that any appreciable size of induction motor will have quite a voltage-disturbing effect on such a small generator.

If there is no voltage regulator and the surges are of long enough duration, a compensating generator voltage regulator will probably remedy the trouble.

For a generator of this size, care should be exercised in the selection of motors, and heavy starting currents (which are an inherent in the squirrel-cage motor, especially if thrown across the line) should be avoided. A squirrel-cage induction motor driving a full-load-torque machine employs a high starting current, which is suddenly applied; and it is impossible for the exciter to pick up in sufficient time, even with a voltage regulator. The voltage regulator, however, would take care of any reasonable shortcomings of the governor.

The generator voltage regulator and excitation will function in sufficient time for reasonable changes in speed of the prime mover, and if the regulator has a line-drop compensator it will compensate for voltage drop in the lines, which otherwise could only be remedied by installing the proper size feeders. Hand control under varying load conditions should always be discouraged. In other words, a generator voltage regulator will take care of any load and reasonable speed changes, but the excitation will rarely function fast enough where large, sudden starting current prevails compared with the generator current output.

JOHN JACOB STEINKE,
Henry R. Kent & Co.
Rutherford, N. J.

A Question for Our Readers

ON A newly erected 550-lb. B. & W. type water-tube boiler bad leakage occurred, not only at the handhole gaskets, but also at the expanded tube joints, although the boiler was carefully tested with cold water pressure before starting up and found to be tight in every respect. By mistake the alkalinity of the boiler water was kept as high as 150 grains of caustic per gallon at the start, and now the question is whether such a high alkalinity may have been the cause of the leakage in expanded tube joints. W. F.

Suitable answers from readers will be paid for and published in the Feb. 4 issue.

WHAT Colloids *ARE* *and Their Place in* Boiler Water Conditioning

By GEORGE C. REINHARD*

COLLOID is the name given to a particular class of substances, of which glue, gelatine, agar-agar, albumen, etc., are examples. Other substances, such as chalk, iron hydroxide, mercury, etc., can also be rendered colloidal. Colloids can exist either in the sol or gel form. A colloidal sol is a very fine subdivision of matter in a liquid medium. The particles approach molecules in size. That which differentiates colloids from true solutions, however, is the fact that they are not molecular dispersions; whereas true solutions are.

Such particles in solution carry a charge of electricity, and the passage of an electric current may cause the colloid to deposit on a pole or electrodes having a charge opposite to that of the colloid. The colloid, upon losing its charge, becomes depeptized and is thrown out of solution. The depeptization of a colloid by any means whatever causes the same action and the colloid reverts to its gel form.

Colloids belonging to the glue-like class of materials, such as gelatin, albumen, etc., are known by the further classification of protective colloids, because they possess the property of rendering colloidal any materials precipitated in their presence. This principle is utilized in the manufacture of ice cream, where gelatin is often added to prevent the formation of ice particles of any appreciable size. In other words, the ice crystals become colloidal.

Dispersing themselves uniformly throughout a medium without agitation, colloids possess the unique property of taking to themselves, by a process of surface condensation (adsorption), materials in solution, such as soluble salts of all kinds, dissolved gases and even other colloids.

When applied to boiler water conditioning, colloids are capable of removing matter originally present in the water by coagulation. Of course, the amount of removal depends upon many factors, such as the concentration of the salts and the absorptive affinity that the colloid has for that particular salt. When scale-forming materials are not absorbed from solution, they may often be disposed of as they first come out of solution. In other words, before scale can be deposited, the material passing from the soluble to the insoluble form must pass through the state of extremely fine particles—a colloidal solution. If this colloid of the scale-forming constituents is acted upon by another colloid bearing opposite electrical charges, both colloids will be depeptized and will coagulate.

Characteristics the ideal colloid should possess are: (1) it should be capable of going into colloidal solution in water; (2) it should under boiler conditions of temperature and pressure, be capable of forming a colloidal gel by coagulation; (3) this gel should be stable under the conditions existing in the boiler, and should not lose the properties that make it unique for the purpose.

Two materials that commonly go into the category of soda compounds, sodium silicate and sodium aluminate, are, strictly speaking, colloids. They are not chemical compounds possessing the formula given to them. Sodium silicate happens to be a hydrate of silica that has been put into colloidal solution by chemical peptization, and the chemical employed for this purpose is caustic soda. Considered from this viewpoint, then, we can trace the action of the colloid when it is added to water to be conditioned, and see whether it meets the requirements of the ideal colloid.

Sodium silicate is a colloidal solution and in this respect satisfies the first condition necessary in the ideal colloid.

The term colloid is one that is frequently used but less frequently understood, especially in its relation to boiler feed-water treatment. The author's discussion of this subject formed part of a paper which he presented before the last annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

But the soda that keeps the silica in colloidal solution is used up in reacting with the scale-forming salts of calcium and magnesium. These salts are precipitated, and the removal of the soda peptizing agent from the silica causes it to revert to the gel form. And there is formed an intimate mixture of the precipitate of calcium and magnesium occluded in the silica gel. Thus the second condition of the ideal colloid is met. However, as the silica gel, carrying the calcium and magnesium, remains in the boiler at the elevated temperature and pressure, the hydrate of silica loses its water and in so doing loses its gel nature. What is left in the boiler is an insoluble, non-colloidal precipitate, much of it silica, virtually a form of rock. It will be seen, from this standpoint, that the third condition is not met.

Considering sodium aluminate, which likewise has been misnamed, being more strictly a colloidal solution of aluminum hydroxide that has been peptized or brought into colloidal solution by caustic soda, we obtain a similar succession of events; but instead of silica as the final product, we obtain oxide of aluminum.

Other colloids suggested in the past for boiler treatment, either with or without regard for the colloid chemistry involved, are starch, gelatin, tannin, etc. Considering these alone will serve the full purpose intended. Starch is rendered colloidal through the use of boiling water, and gels as the solution is allowed to cool down. The same is true for gelatin; at the very outset it can be seen that requirements are not being met, for the ideal colloid should gel, under boiler conditions. Tannin is rendered colloidal by the mere addition of water, but is invariably used with soda in the form of sodium tannate. The soda reacts on the scale-forming matter and is thereby removed from the tannin, which under them has a tendency to form a gel. Unfortunately, this gel has a greater solubility in hot water than it has in cold, and releases by this means the scale-forming matter, no longer exerting a protective colloid effect.

There is one colloid—namely, Algor—which is extracted from a certain vegetable growth, and has been found to possess the requirements mentioned. It needs the presence of soda to effect peptization and put it into colloidal solution. Because of this, chemical reaction can be utilized for the conditioning of water wherever deemed advisable. It is not the intention of colloid chemistry to replace ordinary molecular chemistry wherever the latter can be utilized; in fact, it is wise to recognize any advantage it may possess. Algor colloids will revert to the gel form as soon as the small amount of soda necessary to keep them in colloidal solution is removed by combining with the scale salts of calcium and magnesium. This coagulation causes the insolubles, together with the other colloidal matter and even some of the soluble salts to be occluded in the protective sheath of gel. Prevented from acting as crystalloids, they do not come in close enough contact with each other to adhere as a crystalline deposit.

*Chief chemist, Feedwaters, Inc.

Low-Temperature Carbonization

Seen as Solution to Fumes Problem by British Engineer

NOT so very long ago, say in 1919, the largest power stations consumed only about 100 to 300 tons of coal per 24 hr., that is 30,000 to 90,000 tons per year. But today 1,000 tons of coal per 24 hr. is a common figure for a single station, and stations are under construction which will have eventually a consumption of 5,000 tons per day. Even in the case of stations taking 1,000 tons of coal per day it is impossible, at any rate in Great Britain, to go on squandering all the valuable byproducts that could be extracted from this coal.

Taking average bituminous coal of 25 to 35 per cent volatile matter, one ton of low-temperature carbonization will give, in round figures, 5,000 cu.ft. of 750-B.t.u. gas, 2½ gal. of light oil scrubbed from the gas, 18 gal. of low-temperature tar, and 1,400 lb. of smokeless fuel, with 10 to 12 per cent volatile matter. Also the tar contains about 40 per cent pitch, and 50 per cent is available for Diesel engines if detailed fractionation is not carried out, even when 2 gal. of light oil has been separated. The proper scientific principle is to combine low-temperature carbonization with combustion for large power stations; that is, to treat the 1,000 tons of raw coal for 24 hr. in front of, or adjoining, the boilers. By this method there would be obtained a total yield per 24 hr. of 2,500 gal. of crude light oil and 18,000 gal. of low-temperature tar, while all the gas and the smokeless fuel would be consumed in the boiler combustion chamber in place of raw coal. Naturally, for the same steam production about 1,350 tons of raw coal would have to be used, instead of 1,000 tons, to compensate for the heat loss of the light oil and tar, more valuable, however, than the 350 tons of extra coal. The 2,500 gal. of light oil would give 1,500 gal. of purified petrol along with other products, and 9,000 gal. of Diesel oil.

Take the case of Glasgow, consuming a total of about 275,000 tons of coal in central stations. If low-temperature carbonization combined with combustion were adopted for the generation of electricity, Glasgow would consume about 340,000 tons of raw coal, and produce every year 510,000 gal. of purified petrol and 76,500 barrels of Diesel oil, as well as large amounts of other products, such as solvents, fuel oil, and pitch. For example, the city could run motor buses auxiliary to the trams with her own petrol from Scottish coal, and install Diesel engines at the power stations to take the peak loads, as well as run Diesel engine motor wagons, quite apart from the installation of low-temperature carbonization plants to supply solid smokeless fuel.

Highly important also is that the sulphur problem in chimney gas would be more or less eliminated. Arising out of the litigation in which the Manchester Corporation has been involved concerning the Barton power station, and the thoroughly justified uproar against the new Battersea power station, most large coal-using installations will have to take measures to eliminate or mitigate to a considerable extent the trouble from sulphur. Raw coal varies greatly in sulphur content, generally between about 0.75 to 2.50 per cent. However, we can take as a fair figure an average of total sulphur for British coal as 1.5 per cent, of which probably 90 per cent is converted during combustion into sulphurous and sulphuric acid, and discharged from the chimney. This corresponds to 1.35 per cent "effective" sulphur, and a station burning 1,000 tons of coal per 24 hr. will therefore discharge in this time the equivalent of 13.5 tons of sulphur, or 41.3 tons calculated as sulphuric acid.

At Battersea, for example, on the figure of 2,000 tons of coal per day, this will correspond to 27 tons of sulphur, or 82.6 tons of sulphuric acid, per day. With low-temperature carbonization, however, a large proportion of the total sulphur, probably in average cases well over 50 per cent, is driven off in the gases and vapors, and is easily removed from the gases, after the condensation of the tar, by washing. Under these circumstances, most of the sulphur in the gases is in the simple form of sulphuretted hydrogen (H_2S), and can be removed by water sprays. If, therefore, coal of normal quality is used in the washed condition to reduce the pyrites content, submitted to low-temperature carbonization, and the gas washed, probably in average cases about 65 to 75 per cent of the sulphur would be removed.

This new problem also emphasizes the many claims for the principle of submitting the raw coal in an adjoining setting to combined low-temperature carbonization and total gasification in a vertical continuous setting, condensing the tar, scrubbing for light oils, and removing the whole of the sulphur from the gas, which could then be burned under the boilers in place of solid fuel. In this way sulphur in the chimney gas would be eliminated, and with, of course, absence of smoke, grit, and dust, all the troublesome ash and clinker being removed from the generator and not the boiler combustion chamber.

There are, of course, almost endless methods of combining low-temperature carbonization, gasification, and combustion for large power stations. For example, any low-temperature carbonization plant could be erected next to a power station, and the gas and solid fuel merely taken across to the boiler combustion chambers. From this point of view the choice of processes is somewhat bewildering. For example, there are about 600 processes that have been tried, more or less on the commercial or semi-commercial scale, during the past century and a quarter for the low-temperature carbonization of coal, lignite, shale, cannel, torbanite, general canneloid material, tar sands and bituminous rocks, peat, wood, sewage cake, and general vegetable matter. Certainly about 300 of these processes were regarded as suitable for coal. At the present time there are nearly 150 low-temperature carbonization processes in the world under active consideration.

We have at the present time more

"In spite of all the advances of the past ten years, and those one may expect on the same general lines in the immediate future, there are still a number of serious problems in connection with the coal-fired, condensing, steam-driven super-power station even of the latest type, some of which may be insoluble, as follows: (1) the use of water as the liquid in the boiler; (2) over 50 per cent of the total heat of the coal lost in the condenser; (3) low peak load, probably averaging only about 33 per cent in Great Britain; (4) consumption of raw coal without recovery of byproducts; (5) sulphur in the chimney gases," says David Brownlie, well-known British engineer, who recently discussed the last two named at the Royal Technical College in Glasgow, Scotland. An abstract of this paper is given here.

than 40 processes in Great Britain alone. For large power station work, however, on present knowledge, low-temperature carbonization is chiefly of interest in connection with five general methods, as follows:

1. Combined low-temperature carbonization and combustion in a plant more or less integral with the boiler setting, recovering all the light oil and the tar, with the gas and solid coked fuel burned under the boilers, and to a considerable extent elimination of sulphur.

2. Certain low-temperature carbonization processes specially suited for working in conjunction with steam boiler or other furnace settings but not integral with the setting, recovery of all the light oil and the tar, with the gas and solid coked fuel burned under the boilers, and to a considerable extent elimination of sulphur.

3. Combined total gasification and combustion, having the generator integral with the boiler setting, all the hot, dirty gas being burned direct in the combustion chamber, according to present methods, without recovery of tar or other treatment, giving elimination of sulphur only to a partial extent.

4. Low-temperature carbonization and total gasification in one setting, adjoining but not integral with the power plant, with recovery of tar but no light oil, combustion of gas only in the boiler plant, and total elimination of sulphur.

5. Low-temperature carbonization and partial gasification in one setting, adjoining but not integral with the power plant, with the recovery of tar and perhaps part of the light oil, combustion of gas and solid coked fuel in the boiler plant, and to large extent elimination of sulphur.

Power Plant Insurance

A SUMMARY of the principal forms of insurance covering direct and indirect losses due to accidents in power plants is included in the recent report of the Insurance Committee of the National Electric Light Association cooperating with the Insurance Committee of the American Gas Association. An abstract of the summary is reproduced herewith.

Steam boiler insurance is available for both boilers and pressure vessels subject to internal pressure of steam, air, gas or liquids. It offers reimbursement for damage, (1) to boiler or vessel or to main steam pipes; (2) damage to other property of the assured; (3) damage to property of others for which the assured is liable.

The coverage is effective against the damage caused by explosion, collapse or rupture of the boiler or pressure vessel. The word "explosion" must be defined in order to make clear the protection afforded. "Explosion" in the policy is defined as a "rupture" or "collapse" of any vessel insured under the policy.

"Rupture" means a sudden, substantial and accidental tearing asunder of the boiler or boilers, or vessels, caused by pressure of steam, or by internal pressure of air, gas or liquid, if the boiler is described as containing air, gas or liquid.

"Collapse" means the sudden and accidental crushing or forcing inward, of the furnace or flues of a boiler, caused as above.

Steam and water gages, water column, and safety valves together with their connecting pipes and fittings up to and including the nearest stop valve are covered as a part of the boiler. Steam pipes beyond the first valve and also any vessel or other apparatus subject to internal pressure may be covered by describing them in the policy.

Bulging, or leaking at calking edges is not a rupture, neither are cracks of gradual development included under that term, but in consideration of an additional premium an indorsement to cover losses from such bulging or cracks may be added.

This coverage may include reimbursement for liability for injuries or death of persons not employes of the assured. In some states benefits under workmen's compensation may be included, where the injuries result from a boiler explosion.

The engine policy coverage is similar to that provided by the boiler policy. It reimburses for loss occasioned by accidental breakdown of the engine. It is applicable to engines using steam, oil or gas, and to pumps, compressors, refrigerating and other reciprocating machines.

Damage to the engines and property of the assured is covered; also damage to property of others for which the assured may be held liable.

Overheating, and consequent damage to bearings, and ordinary wear and tear are not considered as accidental breakdown of the machine. Breakdown is defined as a sudden, substantial and accidental breaking of the engine or any of its parts, while running, which prevents continued operation. It includes explosion of fly wheel on the main shaft of the engine, explosion of cylinders, crank and shaft failure, cylinder trouble caused by accidental pressure of water, frame cracks, breaking of reciprocating parts or valve gears and overspeed accidents.

The sudden stoppage or accidental bursting or dislodging of wheels while revolving into two or more parts, when one or more of said parts shall then be completely separated or dislodged from the other part or parts of the wheel, may cause considerable loss or damage, which is covered by a fly-wheel policy.

Electrical machinery insurance has grown out of boiler and engine coverage. Protection against losses resulting from the breakdown of electrical machinery is provided by the policy and follows very closely the engine policy.

A few of the electrical machinery accidents which may cause losses can be accounted for by burn-outs of generators, transformers, motors, switchboards, commutators, and grounds, short-circuits in windings, etc., lightning, broken electrical connections or the explosion of the rotor or commutator from overspeed may cause other accidents. The breakdown of insulation sometimes causes serious accidents, and this may happen for reasons over which the owner of the apparatus has no control.

It is unlike boiler insurance, where the principal damage is to surrounding property, and the boiler is but a small part of the loss. The electrical machinery is itself the expensive piece of property most likely to suffer damage.

The term machine is understood to mean any piece of electrical apparatus described in the policy. Breakdown means the sudden, substantial and accidental breaking down or burning out of the machine while in use or installed and connected ready for use.

Coverage under steam-turbine insurance provides reimbursement for loss occasioned by explosion or burn-out of turbine-generator driven by steam turbine, or breakdown. It includes the explosion of the turbine casing, the burning-out, short-circuiting or breakdown of the electrical end, and the complete dislodging of the motor or loosening or stripping of the blades, buckets or gears.

Breakdown means the sudden and accidental breaking, deformation or burning out of the turbine unit or any part, while in use or while installed and connected ready for use, which prevents continued operation or stops its functions.

Quite recently another form of coverage has been provided. It provides indemnity for loss arising out of the deprivation of usable electric current needed in the conduct of the insured's business resulting from the breakdown of the public utility. The protection is applicable to the customers of the utility rather than to the utility itself, except where it buys power from another source.

Use and Occupancy and Consequential Loss

Use and occupancy insurance may be written in connection with all the forms of coverage discussed under the power plant group, either as an indorsement or as a separate policy. It provides protection against loss of profits and the obligations of fixed overhead expenses, such as interest, taxes, depreciation, salaries and various other items continuing while a plant is shut down as a result of any of the casualties mentioned under this group.

The earnings of the future may be impaired by the inability to occupy and use the premises or the machinery, and thereby constitute an indirect but nevertheless actual loss.

The payment of a specific amount per day for each day of total non-production caused by the accident is covered in consideration of an additional premium.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Spot ✻ News

INSTALLATION *of an air-conditioning system in the White House Executive Offices, which would be linked with the White House proper, is planned, according to an oral statement of Lt. Col. U. S. Grant 3d, director of public buildings and public parks of the national capital.*

* * *

CARBON-MONOXIDE FUMES, *escaping from a tunnel 40 ft. below their dressing room, recently overcame 26 workmen employed by the Byllesby Engineering & Management Corporation on construction work at its Brunot Island power plant. None were fatally injured.*

* * *

CONSTRUCTION WORK *will be started shortly by the Stone & Webster Engineering Corporation on the first stage of the Puget Sound Power & Light Company's 200,000-hp. hydroelectric development at Rock Island on the Columbia River near Wenatchee, Wash. The ultimate cost of this project will be $15,000,000.*

* * *

THE FIRST HALF *of the $10,000,000 hydro-electric project in the Scottish Highlands was completed recently with the blasting out of the tunnel through Ben Nevis mountain, at a depth of 100 ft. below the surface of Loch Treig, Scotland's deepest lake. When finished this will be the largest water-power scheme in Europe, it is expected.*

* * *

APRIL *has again been designated for the annual National Elimination-of-Waste Campaign. This movement, started last year, has grown remarkably and has taken on international aspects with interest being shown by England, Russia, China and Australia.*

* * *

NO REPLIES *have been received as yet to the invitation of the Military Affairs Committee of the House of Representatives calling for bids on Muscle Shoals. The committee will wait until Jan. 15 before giving further consideration to legislation.*

Trade Commission Resumes Hearings in Public Utility Investigation

Counsel for Power Company Cites World War, President Wilson and Former Secretary of the Treasury McAdoo in Defense of Propaganda Activities

NO SPECIFIC CHARGES have been made in the Federal Trade Commission's investigation of the alleged propaganda activities of the public utilities, but the record, although voluminous, is not complete, and parts of it are so fragmentary that it is misrepresentative, Bernard F. Weadock, special counsel, stated Jan. 8, in opening the case for the utilities. To justify the publicity activities of the utilities, he said, it is necessary only to explain the circumstances in which they had their inception; circumstances over which the utilities companies had no control. If in one or two instances they have, in their zeal, departed from their original purpose, the industry should not be condemned for the thoughtless action of a few, said Mr. Weadock.

Publicity Activities

The publicity activities of the utilities originated, said Mr. Weadock, in response to the urgent request made by the government during the war that the utilities secure public support for a necessary national industry. In this connection Mr. Weadock referred to correspondence between President Wilson and Secretary of the Treasury McAdoo in February, 1918, in which Mr. Wilson expressed complete accord with Mr. McAdoo's views concerning the importance of the public utilities in the vigorous prosecution of the war and expressed the hope that state and local authorities would respond promptly to the necessities of the situation. Mr. Weadock explained that this co-operation of the federal government was extended because of the precarious financial condition of many public utilities furnishing transportation, light, heat, and power. Questioned by Commissioner Edgar A. McCulloch, who presided at the hearing, as to what relation the financial condition of the public utilities had to their propaganda activities, Mr. Weadock explained that this publicity organization was created for the purpose of bringing to the attention of local authorities the necessity for prompt relief in the form of increased rates to enable them to meet the needs required by the war-time expansion of industry and trade. Mr. Weadock also referred to an address made by President Wilson at the mid-year conference of the American Railway Association in Washington during January, 1915, in which he stated that first of all among the rules for the conduct of business is the rule of publicity, which he defined as not doing anything under cover and letting the public know what you are doing and judge it accordingly.

After the war, said Mr. Weadock, various channels of information, including state information bureaus, were utilized by the utilities, to assist in securing public understanding of the necessity for expansion and development to keep pace with the nation's growth. Mr. Weadock presented as exhibits several documents, including the school pamphlet, concerning which there has been so much controversy, and a report by the National Education Association's committee on propaganda in the schools presented at the Atlanta meeting of the association in July, 1929. Concerning the school pamphlet, Mr. Weadock stated that it was distributed with the sanction of the educational authorities and that, with trifling exceptions, the various editions of this pamphlet made available to the schools were non-controversial and were wholly factual and technical in their nature. He cited examples to show that it has long been customary for the schools to secure such information from all classes of industry. Teachers welcome it, he said, as an interesting contribution to the regular curriculum which has positive educational value.

Appraisal of Report

Commissioner McCulloch questioned the propriety of including in the record the report of the N.E.A. committee. Mr. Weadock explained that the significance of the report lies in the fact that it presents the findings of educators who have examined all outside material furnished to the schools. Commissioner McCulloch expressed the opinion that in this inquiry it becomes the commission's responsibility to appraise the nature and value of the school material furnished by the public utilities without accepting the judgment of other organizations or persons concerning the same issues.

British Pulverized Fuel Plant Described

In a recent lecture before the Manchester (England) Institution of Electrical Engineers, R. A. Chattock described the pulverized fuel installation at the Prince's Power Station, Birmingham. This new installation consists of six Vickers-Spearing water-tube boilers, each having a normal evaporative capacity of 35,000 lb. of steam per hour. From a central pulverizing house, giving an output of 22 tons of pulverized fuel per hour and fitted with steam operated coal-dryers, the fuel passes on to cyclone collectors and discharges into bunkers, from which it is conveyed to bins erected over the boilers. It is then fed on to fish-tail burners installed in the boiler furnaces.

Difficulty arose in the conveying and packing of the pulverized fuel due to the inability of the dryers to reduce sufficiently the moisture content, which should not exceed 10 per cent, while the cooling effect on the brickwork of the air passed through the hollow combustion chamber walls was insufficient to allow the CO_2 content to be raised above 14 per cent. These boilers have been found to give a combustion efficiency much higher than that obtainable with stoker-fired furnaces, but to compensate for the higher capital costs of the pulverized-fuel equipment compared with mechanical stokers much larger boiler units and several modifications are desirable. Four recently installed boiler units, having a normal evaporation of 150,000 lb. of steam per hour, have been fitted with water screen-tubes round the walls of the combustion chamber, enabling 16 per cent CO_2 content to be obtained, and with rotary kiln-type type dryers reducing the moisture content of the coal to 6 per cent.

Power Commission Reviews New Hydro Projects

A preliminary permit has been issued by the Federal Power Commission to the Mississippi Power Company, a subsidiary of the Alabama Power Company, covering the project at Colbert Shoals on the Tennessee River. The site is 40 miles down the river below Muscle Shoals. The development of that site would have an important bearing on the Muscle Shoals project, if it were used for public utility purposes, as it would enable the plant at the Wilson Dam to operate on peak load. While the head is lower than at Muscle Shoals, the volume of water is slightly larger. The primary power available is 66,000 hp. It is planned, however, to install 160,000 horsepower.

Laurence Macomber of Los Angeles has applied for a perliminary permit covering a project on Waldo Lake in Oregon. It is planned to construct a dam across the outlet of the lake, creating a reservoir of 140,000 acre feet. The power house is to be on Black Creek. There would be a diversion of water from Salmon Creek to that point and all of the water would be diverted to a second power house on the North Fork of the Middle Fork of the Wilamette River. It is planned to install 65,000 horsepower.

All obstacles seem to have been ironed out in connection with the project of the Washington Electric Company at Rock Island on the Columbia River. A draft of the proposed license has been prepared. One of the conditions is that the fishways should be built as may be required by the Secretary of Commerce. It is understood, however, that an agreement has been reached between the company and the Commissioner of Fisheries.

The Madera Irrigation District of Madera, Calif., has applied to the Federal Power Commission for a preliminary permit covering a 100,000-hp. development on the San Joaquin River. It is proposed to construct a storage dam 4,500 ft. across and 300 ft. high.

An application for a license for a constructed power project on Dewey Lake and Icy Lake, on public land in the vicinity of Skagway, Alaska, has been filed with the commission by the Home Power Company of Skagway.

Society Changes Its Name

ANNOUNCEMENT has just been made that "Engineering Foundation, Inc.," is the new name of the United Engineering Society, a non-profit, membership corporation organized for the advancement of the engineering arts and sciences by the four founder societies: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers.

Objections had been voiced from time to time to the name "United Engineering Society," according to the announcement, and experience for many years had demonstrated that this name caused confusion, misconceptions and other difficulties. The organization is not a "society" in the usual conception of the word. It is a corporation administering real estate, funds and a library, for scientific, educational and other purposes beneficial to the public through the engineering profession and the related sciences and industries. Its functions correspond closely to those of corporations of universities and of foundations for scientific, social or economic research. It is truly a foundation; the name "engineering foundation" is appropriate. Therefore, with the approval of the founder societies its name was changed Jan. 1, 1930.

$10,000 Award Announced for Scientific Work

The largest single monetary award in America for scientific accomplishment has been created by *Popular Science Monthly*, which, beginning this autumn, will confer an annual prize of $10,000, accompanied by a gold medal, upon the American citizen who has been responsible, during the preceding year, for the achievement in science of greatest potential value to the world.

The award will be bestowed under the auspices of the Popular Science Institute, a research organization maintained by the magazine, of which Prof. Collins P. Bliss, associate dean of New York University, is director. The institute has enlisted the services of twenty-four leaders in American science to serve as a committee of award, whose task it will be to select the prize-winning effort.

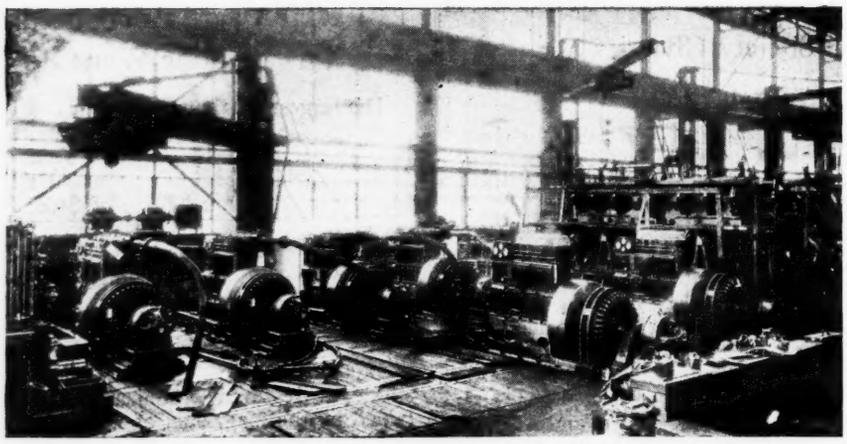
It is explained that the award is intended to heighten the interest of the American people in those conquests of the laboratory and the workshop which benefit the entire community and to focus attention upon the many scientific workers who, without thought of personal profit, toil to better man's control over his physical surroundings.

Two $1,000,000,000 Utility Systems in Mergers

Billion dollar mergers are the order of the day, if last week's actions of utility systems can be taken as indicative of present trends. On Jan. 7, the directors of five companies took action that will reduce considerably the pyramid of holding companies in the $1,200,000,000 system, placing the Commonand Southern Corporation, formed last spring, directly at the head of the numerous operating concerns in the system.

To carry out this measure directors of the Allied Power and Light Corporation, the Commonwealth Power Corporation, the Penn-Ohio Edison Company, the Southeastern Power and Light Company and the Commonwealth and Southern Corporation approved a plan of merger and consolidation. This will result, when completed, in the acquisition by the Commonwealth and Southern Corporation of all assets and its assumption of all liabilities of the four other companies.

On the same day public utility properties of the Standard Gas and Electric Company and the Standard Power and Light Corporation, valued at $1,100,000,000, were united in a more compact utility system under a plan for changing the corporate structures of the two concerns. By this agreement H. M. Byllesby & Company and the United States Electric Power Corporation jointly share control of the Standard public utility system under what is virtually a partnership agreement, with active management of the properties retained by the Byllesby interests.



ON THE BLOCK, these seven Diesel generating sets are being put through their paces at the Cooper-Bessemer factory, Grove City, Pa., prior to shipment to the Texas Empire Oil Company, where they will be used in pipe-line pumping stations.

Progress Reported on Smoke Abatement at Battersea

The government report on the smoke nuisance of the proposed Battersea Power Station, London, has just been issued through the Ministry of Transport. Comprising the interim report of the committee presided over by the government chemist, it explains that the problem was approached as one of gas-scrubbing. The main practical consideration was: could the chimneys and perhaps the flues of the proposed plant provide sufficient scrubber capacity? To determine this an experimental plant was used consisting of a cylindrical tower into which the gases are drawn by a fan. In the tower the gases are submitted to scrubbing treatment by water delivered through a centrifugal pump to spraying devices.

The findings and data of the advisers to the power company were examined by the committee, who commented on them as follows: "Generally, we may say at the start that we consider the experimental work so far proposed indicates that by the use of water sprays, it is possible to eliminate from the gases of combustion nearly the whole of the sulphur gases present. We had the opportunity of inspecting the experimental arrangements. Neither acid taste nor objectionable odor could be detected by breathing the undiluted treated gases coming from the exit flue. The analytical results were checked by a representative of the government laboratory and the absorption of about 95 per cent of the sulphur acids of the flue gases were confirmed.

"While we believe the process has afforded promising results, we consider that there are features in the experimental apparatus and process which are still obscure, so that while we think there is no inherent reason why similar results should not be obtained from the larger experimental plant now being erected on the lines of a projected installation at Battersea, we prefer to await the results afforded by this larger experiment. We think it necessary that a more definite explanation of the mechanism of the oxidation of sulphurous to sulphuric acid in the experimental process should be forthcoming before we can report on the practicability of the process. In connection with this power station very large quantities of condenser water are to be used, as much as 500 tons, we were informed, for every ton of coal burned. A portion only of this quantity should be required for washing the gases."

Finally, the committee has ascertained that mechanical separators are to be used for eliminating the bulk of the dust; the washing process which the gases undergo for removal of sulphur acids should prevent the escape of most of the residual particles, but the committee has received no experimental data on this aspect of the question.

E.I.C. to Hold Annual Meeting at Ottawa, Feb. 12-14

The Engineering Institute of Canada will hold its annual meeting this year at the Chateau Laurier in Ottawa, Ont., on Feb. 12 to 14. Preceding this the general professional meeting of the institute will be convened for formal business at headquarters in Montreal on Jan. 23.

Featuring the engineer's part in the development of Canada's natural resources, the technical program of the annual meeting will cover a wide variety of topics. Included on the list are the application of aerial surveys to engineering problems, aeronautical research, radio, water powers, surveys in general, the Montreal South Shore Bridge, and six-wheel tractors.

Social features of the meeting provide an interesting trip to engineering works, a luncheon and smoker for members, and special entertainment for the ladies.

High-Pressure Boiler Pumps to Be Installed

Several high-pressure boiler feed pumps have been ordered recently for early installation in various central stations. The Electric Management & Engineering Corporation, engineers for the Jersey Central Power Company, at South Amboy, N. J., will install two Worthington 7-stage centrifugal units to operate at 137 to 740 g.p.m. at 1,350 to 765 lb. differential pressure with a water temperature of from 324 to 500 deg. These will be driven by 600-hp. direct-connected motors at a speed of 3,500 r.p.m. Two similar units have been ordered by the San Antonio Public Service Company, of Texas.

A feature of these pumps is a vertically-split section casing. Each stage piece, as well as the suction and discharge heads, are of cast-steel construction, held in rigid assembly by through bolts.

The Waukegan Generating Company will install two 8-stage turbine-type pumps, duplicating the original pump in its station. These units are designed for 700 g.p.m., 260-deg. water at 850-lb. discharge pressure, and a speed of 1,750 r.p.m.

New Steam Plant at Mount Isa Mines

A new steam power plant is being installed at the lead mines near Mount Isa—an isolated, hot, waterless locality in North Queensland, Australia—by the Mount Isa Mines, Ltd. The installation comprises two 5,000-kw. turbine-generators supplied with steam by B. & W. boilers. The latter will be equipped for pulverized-coal firing with Fuller pulverizing machines. Storage space for approximately 5,000 tons of coal will be provided, with drag-line scrapers to convey the fuel to the power house. Electric power will be generated at 3,300 volts and distributed at 400. The entire settlement will be electrically lighted.

Discussion of Wire-Rope Problems Available

Proceedings of the Third Conference on Wire-Rope Research are ready for distribution. These proceedings contain papers describing the use and abuse that wire rope receives in many industries. The authors include Messrs. Coley, Lindquist, and Paine, on the field of elevator use; D. C. Sherman, cableways; W. M. Bager, excavating machinery; Prof. Emanuel Fritz, logging; J. R. McCausland, generating plants; and others familiar with this important machine element.

A brief abstract of the paper by Dr. R. Woernle describing the work of the German committee on wire rope, and tentative test specifications for wire ropes sponsored by the Deutscher Ver-

band fur die Materialprufungen der Technik under the procedure of the Verein Deutscher Ingenieure, are included in this research collection. Copies may be obtained from the American Society of Mechanical Engineers.

The A.S.M.E. Research Committee is now considering the organization of a special research committee to conduct an exhaustive investigation of the wire-rope problem.

Los Angeles Power Board Reorganized

The Los Angeles Board of Water and Power Commissioners has reorganized the Los Angeles Department of Water and Power and has set up two separate bureaus, one to be known as the Bureau of Power and Light and the other to be designated the Bureau of Water Works and Supply. This, in effect, has re-established the municipal bureaus as they were nine months ago. At that time H. A. Van Norman was made general manager of the combined departments. In the resolution, which was introduced by Commissioner H. G. Palmer, the reason for the change was stated as the imperative necessity that the Water Bureau shall have at this critical time the entire thought, energy and time of a manager.

Under the new plan H. A. Van Norman will be general manager and chief engineer of the Bureau of Water Works and Supply. E. F. Scattergood is to be general manager and chief engineer of the Bureau of Power and Light.

Westinghouse to Build New Engineering Laboratory

An expenditure of $1,500,000 will be made by the Westinghouse Electric & Manufacturing Company in the construction of a central engineering laboratory and an addition to the present direct-current power laboratory, both in East Pittsburgh. This was announced today by F. A. Merrick, president of Westinghouse.

"The buildings will house one of the world's best-equipped electrical laboratories," Mr. Merrick said. "Generators big enough to supply electricity to a town of 10,000 people will be used merely for experiments. Artificial lightning for testing insulating materials will be produced by a high-voltage surge generator. Test circuits of almost any voltage and frequency will be provided for.

"Making artificial weather—hot or cold—will be every-day routine in the weathering rooms, where sunshine or rain, winter cold or summer heat, will be produced for testing apparatus built for outdoor service. In another room any given set of atmospheric conditions of temperature, pressure, and humidity may be accurately reproduced."

Work has already started on the laboratory, an eleven-story structure 80 ft. wide and 225 ft. long. Adjacent to this building will be the 125-ft. extension to the direct-current laboratory.

Business Forecast

IN ITS ISSUE OF JAN. 15, the *Business Week* will print the following outlook:

"Though the country was as fundamentally sound as usual around the turn of the year, business was a good deal more slack than usual. Generally, it is now merely marking time to keep its feet warm, and the records of basic industrial activity and trade now more clearly suggest comparison with 1924 than with 1927. While trade sentiment is good and the output of optimism continues high, it is too early as yet to see much concrete evidence of improvement. The next two or three weeks must pass before it will be possible to gage the period and strength of revival. Money, banking and security market conditions are still doubtful. Steel activity has not yet picked up; little increase in building can be expected for several months; and before setting its production schedules the automobile industry is waiting the results of the automobile shows to determine the degree of public auto-intoxication that may be counted on this year. But the incoming records of December retail trade are surprising and reassuring as regards general buying power, as is the strength of general price levels.

"The theater of significant events for American business has shifted now to Europe. The Naval Conference at London, the final financial liquidation of the war at The Hague, the renewed movement toward a tariff truce at Geneva—all may have a profound influence for better or worse on world business for years to come."

Southern Utilities Merge

Merger of eight utility companies owned by the Cities Service Company in eastern Tennessee and western North Carolina into one operating company, known as the East Tennessee Light & Power Company, has been announced by C. E. Ide, general manager of the properties. Authority for the consolidation already has been granted by the Tennessee railroad and public utilities commission. Properties involved are the Bristol Gas & Electric Company, Bluff City Electric Light & Power Company, Butler Light & Power Company, Erwin Electric Light & Power Company, Watauga Power Company, all in Tennessee; and the Elk Park Electric Light & Power Company, Newland Electric Light & Power Company, and Roane Creek Electric Light & Power Company, in North Carolina.

Seek to Dissuade Arizona From Filing Suit on Boulder Dam

Action by the Secretary of the Interior in calling a conference Jan. 20 of the governors of the states in the lower Colorado River basin was taken, it is believed, as an eleventh-hour effort to dissuade Arizona from filing its suit. The understanding was that the suit would have been filed by this time had it not been for that move of Secretary Wilbur. It is assumed that Arizona was willing to await the outcome of another conference, even if the prospects of its being successful are remote. If Arizona is not satisfied at that conference—few expect anything to come from it—it is assumed that suit will be filed at once.

Regardless of the outcome of the conference at Phoenix, Secretary Wilbur has announced his intention of signing contracts as soon after Feb. 1 as possible to cover the power to be developed at the Boulder Dam. This will enable Congress to proceed with the appropriation of the money for construction.

The law provides $165,000,000 to be paid back in 50 years to the Government at 4 per cent interest. Included in this amount is $40,000,000 for the proposed all-American canal for the benefit of the water users in the Imperial and the Coachella Valleys in California.

In a recent ruling the Attorney General, William D. Mitchell, held that this $40,000,000 would not bear interest. Included in the $165,000,000 is $25,000,000 for flood control which is to be repaid out of excess profits over the 50 annual payments.

Los Angeles to Need Power

That a large block of continuous power from Boulder Dam will be needed for operation of the Los Angeles aqueduct is indicated by the preliminary report made to the directors of the metropolitan water district by the board of review appointed to select the most feasible route for the proposed aqueduct to bring water from the Colorado River to Southern California.

This report recommended the elimination of all the so called gravity routes from further consideration and requested more detailed engineering and geological information along the four tentatively selected pumping routes.

In the light of all considerations, the report states, "the only present practicable supply of water from the Colorado River is to be obtained as a pumped supply through an aqueduct so located as to take full advantage of the topographical features of the country through which it passes, always keeping the pump lifts down to the lowest practicable minimum and bearing in mind the desirability of connections which may be made in the future for the purpose of eliminating all or a large part of the pumping lift."

The board, composed of A. J. Wiley, consulting engineer of Boise, Idaho

Richard R. Lyman, consulting engineer of Salt Lake City, Utah; and Thaddeus Merriman, chief engineer of the Board of Water Supply, New York City, has the option of selecting the most feasible aqueduct route, either from the 56 routes officially proposed by the Los Angeles Bureau of Water-Works and Supply or from the several others suggested by private engineers.

Power Equipment Exports Show Gain

Exports of electrical machinery and apparatus showed a substantial increase during the first eleven months of 1929 as compared to the first eleven months of 1928. Tables recently compiled by the Department of Commerce give the sum of $110,685,345 as the value of the exports during that period. Valuation during the eleven-month period of the preceding year placed domestic exports at $82,135,851.

During November, 1929, $11,767,275 worth of electrical machinery and apparatus was exported, as compared with $8,867,064 during the previous November.

A slight decrease was noted in the export of direct-current generators during November, 1929, but this reduction was more than compensated for in the increased exports of generators of alternating currents. Direct-current generators under 500-kw. exports dropped from a value of $135,121 for November, 1928, to $96,369 for the following November. Direct-current generators of 500 kw. and over increased in export valuation from $48,764 to $63,981.

Steam turbine-generators showed a strong development, jumping from $50,419 to $170,909. Export value of accessories and parts for generators increased from $98,586 to $188,021, in comparing the two Novembers.

Wilfred Lewis, Gear Expert, Dies at Sea

Wilfred Lewis, noted gear expert and president of the Tabor Manufacturing Company until his retirement a year ago, died of apoplexy at sea, while on a world cruise with his wife, according to an Associated Press dispatch of Dec. 30, 1929, published in the New York *World*. He was 75.

Mr. Lewis was recognized as a world authority on gears and was the inventor of about 40 devices. He was awarded a gold metal by the American Society of Mechanical Engineers in 1927 for his contributions to the design and manufacture of gear teeth. He also received the Longstreth Medal of the Franklin Institute in 1927 for perfecting a mold machine used in casting. He held a life membership in the A.S.M.E. and served as its vice-president from 1901 to 1903.

Born in Philadelphia, Mr. Lewis received his early education there, graduating from the Friends' Central School in 1871. He received his engineering degree from Massachusetts Institute of Technology in 1875 and entered the employ of William Sellers & Company, in Philadelphia, in that year. When he left the Sellers firm in 1900 to head the Tabor company he had attained the position of director of the former.

Coming Conventions

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

Engineering Institute of Canada. Annual meeting at the Chateau Laurier, Ottawa, Ont., Feb. 12-14, 1930. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

Power Committee Asks for Discussion

The Power Generation Committee of the American Institute of Electrical Engineers has appointed a sub-committee to investigate the question of whether members of the institute who are employed or connected with industries feel that their interests are being served by the reports of the committee or the papers presented for which the committee is sponsor. Such members who are interested in this matter should communicate with Frederick A. Scheffler, 85 Liberty St., New York City.

PERSONALS

GORDON FOX, electrical engineer with the Freyn Engineering Company, of Chicago, who is at present a member of the group of Freyn engineers working on plans for the expansion of the steel industry in Russia, writes an interesting account of his experiences for the January issue of *Freyn Design*.

JAMES F. TOLLARD, manager of the Coast Valleys Division of the Pacific Gas & Electric Company, has resigned from that company and is leaving California for Seattle, Wash., to take up on Jan 15 the duties of general manager of the Seattle Lighting Corporation, newly acquired subsidiary of the Central Public Service Corporation. He will succeed F. K. Lane.

FRANK W. FUNK has been made managing engineer of the Jackson, Mich., division of Stevens & Wood, New York City.

JOHN E. BARKLE, superintendent of generating apparatus at the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company, has been promoted to the position of works manager at the South Philadelphia factories of the company. Mr. Barkle joined the Westinghouse organization in 1901, and was at one time assistant superintendent of the power department at East Pittsburgh.

G. L. BOCKUS is now with A. J. F. Montabone, consulting engineer of Montreal, Quebec. Mr. Bockus was for several years superintendent of power for the city of Sherbrooke, Quebec, and later became connected with the Shawinigan Engineering Company, Ltd., at Montreal.

R. G. WATSON has joined the engineering staff of the Beauharnois Power Company, Beauharnois, Quebec. He was at one time mechanical superintendent of the Nova Scotia Steel & Coal Company, and in 1925 was chief engineer of the St. John Dry Dock & Shipbuilding Company.

A. E. KNOWLTON, formerly associate professor of electrical engineering at Yale University and a member of the Public Utilities Commission of Connecticut, has joined the editorial staff of *Electrical World* as associate editor.

EDWARD B. MEYER, formerly chief engineer of the Public Service Production Company, Newark, N. J., has been elected vice-president of that company, which is a division of United Engineers & Constructors, Inc. Mr. Meyer has passed successively through the various engineering branches of the central-station industry.

Business Notes

International Combustion Engineering Corporation's temporary equity receivership was made permanent Jan. 6 by Federal Judge Alfred C. Coxe after a joint meeting of the stockholders and creditors in the Federal Building, New York City. Wilbur R. Wood, president of the corporation, and the Irving Trust Company were appointed receivers, the latter to succeed Nathaniel A. Elsberg, temporary receiver, who could not continue to serve because of a planned voyage to Europe.

Fitkin Securities Corporation has been created by A. E. Fitkin to own a controlling interest in A. E. Fitkin & Company and its engineering and management subsidiary, the United States Engineering Corporation. J. M. Bowlby is president of the new corporation.

Abitibi Power & Paper Company, Ltd., of Montreal, has applied to the New York Stock Exchange for the listing of 100,000 shares of additional no-par-value common stock. This stock will be used to acquire all, or not less than 90 per cent, of the common stock of Provincial Paper, Ltd.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has organized nineteen wholesale electrical supply companies, with branches in 60 cities, into a single system under the name of the Westinghouse Electric Supply Company, with headquarters at 150 Broadway, New York City. Previous to the reorganization, these companies were owned by the Westinghouse Commercial Investment Company, but conducted business under their own names. One of the objectives of the new system is to secure greater efficiency in distribution and to this end central reserve warehouses are being established in Boston, New York City, Syracuse, Philadelphia, Tampa, Detroit, Indianapolis, Chicago, St. Paul, St. Louis, Dallas, Los Angeles, Portland, Ore., and Seattle, which will serve all of the 60 houses.

Trade Catalogs

Compressors—The Chicago Pneumatic Tool Company, 6 East 44th St., New York City, has just issued a second edition of its 8-page illustrated bulletin 786, which gives complete details on type P-6 DE vertical duplex single-acting compressors.

Electrical Devices—An extensive and authoritative treatise on the design, characteristics and application of the induction voltage regulator is contained in a 112-page illustrated booklet, GEA-1030, of the General Electric Company, Schenectady, N. Y. Other recent publications of the company include: GEA-318B, on insulator units for outdoor service; GEA-89B, on automatic switching equipment; GEA-570B, on hand-starting compensators; GEA-1169, on carrier-current telephone equipment; GEA-913B, on automatic time switches; GEA-897A, on small air-cooled transformers; GEA-1173, on oil circuit breakers; and GEA-548B, on totalizing recording instruments and indicators.

Gages—Complete data on Bristol recording pressure and vacuum gages are given in catalog No. 1009 recently issued by the Bristol Company, Waterbury, Conn. The booklet contains descriptions of the various instruments and a full list of the charts available for a host of applications.

Generators—Bulletin No. 106 of the Engberg Division of the Troy Engine & Machine Company, St. Joseph, Mo., contains a detailed description of Engberg direct-current generating sets. Many illustrations are included in this 16-page booklet.

Water Walls—A detailed description of Nygaard water-wall blocks is given in Bulletin B-71 just issued by the Bernitz Furnace Appliance Company, 89 Broad St., Boston, Mass. Illustrations showing the method of installation in typical furnaces add greatly to the interest of this 12-page publication.

Feed Water—Bulletin No. 24 of the National Aluminate Corporation, 6216 West 66th Pl., Chicago, Ill., entitled "Guarding Against Caustic Embrittlement," is an interesting summary of the latest developments in feed-water treatment.

With the Society Sections

A.S.M.E., Anthracite-Lehigh Section. Dinner and meeting at the Hotel Americus, Allentown, Pa., Jan. 21, at 6:30 p.m. Subject: "Economical Generation and Distribution of Power," by W. A. Shoudy, consulting engineer, New York, and associate professor of mechanical engineering at Columbia University.

A.S.M.E., Boston Section. Dinner and meeting at the Engineer's Club, 2 Commonwealth Ave., Boston, Jan. 15, at 6:30 p.m. Subject: "Carry the Load," by Alex D. Bailey, superintendent of generating stations, Commonwealth Edison Company, Chicago, Ill.

A.S.M.E., Detroit Section. Meeting at the Detroit Engineering Society Building, Jan. 20, at 8 p.m. Subject: "The Coal Situation," by Morgan B. Smith, formerly with the General Motors Corporation.

A.S.M.E., Metropolitan Section. Meeting in Room 502, Engineering Societies Building, Jan. 21, at 8 p.m. Subject: "The Recovery of Dust from Pulverized-Coal-Fired Stacks," by N. W. Sulzer, Eastern district representative, Research Corporation.

A.SM.E., Philadelphia Section. Meeting at the Bellevue-Stratford Hotel, Jan. 28, at 8 p.m. Subject: "The Pioneer High-Pressure Industrial Plant of America," by W. E. S. Dyer, consulting engineer, Philadelphia. At this meeting descriptive data on the Philip Carey 1,840-lb. pressure plant, using reciprocating engines, will be presented.

Engineering Societies of Boston. Annual dinner and gala entertainment will be given at the Copley Plaza Hotel on Feb. 12.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25 @ $2.50
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.50 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.20
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.40@ 1.50

FUEL OIL

New York—Jan. 9, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Jan. 2, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.695 per bbl., or 42 gal.; 26@28 deg., $1.745 per bbl.; 28@30 deg., $1.795 per bbl.; 30@32 deg., $1.845 per bbl.; 32@36 deg., gas oil, 4.651c. per gal.; 37@40 deg., distillate, 5.73c. per gal.

Pittsburgh—Jan. 7, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.25c. per gal.

Philadelphia—Jan. 2, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Jan. 7, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Jan. 2, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.02½@$1.07½ per bbl.; 30@32 deg., $1.30@$1.35 per bbl.

Boston—Jan. 2, tank-car lots, f.o.b., 12@14 deg., Baumé 4.25c. per gal.; 28@32 deg., 5.4c. per gal.

Dallas—Jan. 4, f.o.b. local refinery 26@30 deg., $1.40 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Morrilton — City will not construct power plant. Burns & McDonnell Engineering Co., 401 Interstate Bldg., Kansas City, Mo., Engr. Project abandoned.

Conn., Hartford—Southern New England Ice Co., R. G. Hadley, 48 Edwards St., is receiving bids for the construction of an ice manufacturing plant. Estimated cost $150,000. R. B. Engineering Corp., 11 East 42nd St., New York, is engineer. Contracts let for equipment.

Conn., Newington—U. S. Veterans Bureau, 764 Arlington Bldg., Washington, D. C., will receive bids until Jan. 30 for the construction of a hospital, including ice plant, radio system, etc., here. Estimated cost $1,000,000. Private plans.

D. C., Washington—Potomac Electric Power Co., will soon award contract for the construction of a sub-station. Estimated cost $40,000. A. B. Heaton, 1211 Connecticut Ave., is architect.

Fla., Ocala—Marion County Power Co., R. L. Anderson, Jr., Atty., plans the construction of a hydro-electric plant and dam, 33 ft. high and 5,500 ft. long on river between Jordans and Ft. Brooks landings to develop 16,000 hp. Estimated cost $1,700,000. E. S. Kellebrew, Cordele, Ga., is engineer. S. B. Appleby, Washington, D. C., is interested.

Ind., Indianapolis—Indiana Insane Hospital, will receive bids until Jan. 31 for the construction of a hospital, including power house at 3000 West Washington St. Estimated cost $150,000. Bevington & Williams, 1139 Knights of Pythias Bldg., are engineers.

Md., Glen Arm — School Sisters of Notre Dame, Charles St. Ave., awarded contract for the construction of a 3 and 4 story sanitarium, including power plant, oil burning equipment, etc., to Henry A. Knott, 2107 North Charles St. Estimated cost $500,000.

Mass., Boston—Boston & Albany R.R. Co., South Station, will soon award contract for the construction of a boiler house on Cambridge St. Estimated cost $75,000. G. A. Kirley, is chief engineer.

Mass., Dorchester (Boston P. O.)—Rubel Ice Corp., c/o A. W. K. Billings, 80 Boylston St., Boston, Archt., will soon award contract for the construction of a 1 story, 100 x 300 ft. ice plant at Geneva Ave. and Beechwood St. Estimated cost $100,000.

Mass., East Boston (Boston P.O.)—Boston Ice Co., 11 Deerfield St., Boston, will soon award contract for the construction of a 120 ton ice plant on East Eagle St. here. Estimated cost $80,000.

Mich., Detroit—Dept. of Water Supply, 735 Randolph St., awarded contract for electric motors for centrifugal pumps for low lift pumping plant, Waterworks Park to Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., $34,382.

Mich., Detroit—State of Michigan, Naval Reserve, G. R. Thompson, Budget Dir., Lansing, will receive bids until Jan 17 for the construction of a 4 story armory including steam heating system, boilers, elevators, etc. on East Jefferson Ave. for Michigan Naval Reserve. Estimated cost $5C0,000. Stratton & Hyde, 904 Marquette Bldg., are architects.

N. J., Asbury Park—E. H. Schnieder, Third Ave., Spring Lake, Archt., will receive bids about Jan. 15 for the construction of an 11 story apartment building, including steam heating and refrigeration systems, boilers, elevators, etc., at Grand and 5th Ave., for Peoples Building & Construction Co., 218 Sanford St., New Brunswick. Estimated cost $500,000.

N. J., Jersey City—Harris & Sohn, 58 Park Pl., Newark, Archts., will receive bids about Feb. 5 for the construction of a 10 story medical office building including steam heating and ventilation systems, boilers, elevators, etc., at Sip and Tounale Aves. for Journal Sq. Medical Building Inc., c/o architects. Estimated cost $1,000,000.

N. J., Paterson—Bd. of Chosen Freeholders Court House, will receive about Mar. 1 for the construction of an 8 story county detention jail including steam heating and ventilation systems, boilers, elevators, etc., at Grand St. between Spring and Jackson Sts. Estimated cost $1,000,000. H. B. Crosby, First National Bank Bldg., is architect.

N. Y., Brooklyn—Rubel Coal & Ice Co., 937 Fulton St., will receive bids after Feb. 1 for the construction of a cold storage warehouse. Estimated cost $350,000. H. J. Nurick, 44 Court St., is architect.

N. Y., New York—Home for Incurables, A. L. Mills, Pres., 3rd Ave. and 183rd St., awarded contract for the construction of a hospital and home to include power plant, etc. to William Crawford, 7 East 42nd St. Estimated total cost $1,400,000.

N. Y., New York—New York Edison Co., M. S. Sloan, Pres., 4 Irving Pl., and associated electric light and power companies, will in 1930 expend $76,848,053 for construction purposes according to budget just approved. Plans include generating stations, $20,581,095, substations, $1,204,008, buildings and yards $2,458,000, transmission and distribution $50,250,950, miscellaneous, $2,354,000 and transportation equipment, $1,000,000.

N. Y., West New Brighton (sta. Staten Island)—Dept. of Parks, New York, will receive bids after Jan. 15 for the construction of a boiler room, shops, etc. here.

O., Cincinnati—Hamilton County Tuberculosis Commission, Court House, received lowest bid for the construction of a power plant, laundry, etc., on Guerly Rd. from C. F. Meinkin, 2143 Bernard Ave. $180,765.

O., Cleveland—Cleveland Electric Illuminating Co., Illuminating Bldg., is receiving bids for the construction of a 1 story, 30 x 66 ft. electric substation at 3600 Ridge Rd. Estimated cost $40,000. Private plans.

Pa., Philadelphia—Lit Bros., 8th and Market Sts., plans the construction of a power plant at 7th and Filbert Sts. Estimated cost $250,000. Simon & Simon, Fidelity-Philadelphia Bank Bldg., are architects.

Tex., Big Springs—Texas & Pacific Ry. Co., Dallas, awarded contract for the construction of a round house machine shop, power house, etc., here to R. E. McKee Construction Co., Big Springs. E. F. Mitchell is chief engineer.

Tex., Brownsville—Brownsville Water District, c/o V. L. Conrad, or E. C. Sams, New York, plans irrigating 1,750 acres of land 10 mi. from Brownsville, taking water from Rio Grande River and laying distribution system, pumping unit, etc. Estimated cost $175,000.

Tex., Deport—City voted $45,000 bonds for the construction of a waterworks system including pumping unit, etc.

Tex., Raymondville—Hill & Morton, Brownsville, will build a 15 ton ice plant. Estimated cost $30,000.

Tex., San Antonio—Southwestern Bell Telephone Co., c/o H. Martyn, Local Mgr., is having plans prepared for super-structure of an 8 story building including power plant unit, heating system, elevators, etc. Estimated total cost $2,250,000. Private plans. Contracts let for foundation, excavation and fabricating steel.

B. C., Rossland — West Kootney Power & Light Co., has made application to Provincial Government for permit to construct a power plant and dam 350 ft. on Pend Oreille River, 17 miles from its junction with the Columbia River in Canadian territory to develop 350,000 to 400,000 hp. Estimated cost approximately $18,000,000. L. A. Campbell is engineer.

Ont., Brantford—City awarded contract for three 360 hp. Diesel engines direct connected to electrical generators, in connection with proposd waterworks system to Jordan Roberts Co., Morrell St. $15,000.

Ont., Lucknow—City Council, plans an election soon to vote $70,000 for waterworks improvements, including gasoline and electric pumps, mains, etc.

Ont., Meaford — Canadian Terminal System, 360 St. James St., Montreal, Que., plans the construction of a grain elevator, 2,000,000 bu. capacity, here. Estimated cost $500,000. Private plans. Conveying equipment, etc., will be required.

Ont., Niagara Falls—City will receive bids about Feb. 1 for waterworks improvements including filtration plant, pumping station. G. Acres, Ferry St., is engineer.

Ont., Toronto — Canadian Pacific Ry. Co., H. C. Windsor Station, Montreal, Que., awarded contract for a 21 story addition to Royal Park Hotel, to Anglin-Norcross, Ltd., Temple Bldg. Estimated cost $1,000,000. Steam heating system, etc. will be installed.

Ont., Toronto—Toronto Electric Commission, P. E. Hart, Ch. Engr., plans the construction of a substation on Duke St. Estimated cost including equipment $1,300,000.

Ont., Woodstock—Dept. of Public Works, Toronto, awarded contract for the construction of a new boiler house, dormitory, dining hall, etc. to Schultz Construction Co. Ltd., 45 Albion St., Brantford. Estimated cost $300,000.

Que., Drummondsville — Southern Canada Power Corp., 355 St. James St., Montreal, plans the construction of a power development here. Estimated cost approximately $6,000,000.

Que., Montreal—R. R. Soeurs de Misericorde, awarded contract for the construction of a 43 x 127 ft. power house to U. Boileau Ltd, 4869 Garnier St. Estimated cost $75,000.

Peru—Cerro de Pasco Copper Mining Co., 44 Wall St., New York, N. Y., had plans prepared for the construction of a hydro-electric development, also electrolytic refinery in vicinity of Oroya and Cerro de Pasco; $6,000,000 and $1,000,000 respectively; bids on separate contracts about Mar. 1 for ore crushing and concentration plant at Oroya $7,000,000; tunnels, timbering, excavation, etc., outlying mines from Cerro de Pasco, $1,000,000. Work by day labor.

Equipment Wanted

Boilers, Stokers, etc.—Indianapolis, Ind.—Bd. of Trustees, Central State Hospital, will receive bids until Jan. 31 for the installation of boilers, stokers, also heating and ventilation system in women's building of Central State Hospital.

Electrical Equipment and Pumps—St. Clair Shores, Mich.—City will receive bids until Jan. 21 for electrical equipment, pumps, etc., for proposed sewage treatment work. This corrects report in Jan. 7 issue.

Transformers, Switchgear and Condenser — Wellington, N. Z. — Public Works, Supply & Tenders Committee, will receive bids until Apr. 29 for 34,000 kva. transformers, 11,000 v. switchgear for water rheostats and 10,000 kva. synchronous condenser.

Industrial Projects

Ind., Marion—Craftsman Tool Co., awarded contract for the construction of a 40 x 100 ft. factory at 11th and Miller Sts., to G. W. Heinzman & Son, Marion. Estimated cost $43,000.

Mass., Hyde Park — Englander Spring Bed Co., 1604 Hyde Park Ave., is receiving bids for the construction of a 3 story, 40 x 60 ft. factory. Estimated cost $50,000. J. W. Pearson & Co., 25 Huntington Ave., Boston, are architects.

Mo., St. Louis—Johnston Tin Foil & Metal Co., 6106 South Broadway, awarded contract for a 2 story, 100 x 104 ft. addition to factory at 6130 South Broadway to Gillespie & Daly, Inc., 418 International Bldg.

N. J., Camden—Aircraft Engine Co., c/o Bennett McLaughlin Co., 3434 Sansom St., Philadelphia, Pa., Gen. Contr., will build a 1 story, 75 x 140 ft. factory at Central Airport.

N. J., Harrison—Driver-Harris Co., Middlesex St., is having plans prepared for a 1 and 2 story addition to factory for the manufacture of alloys for electrical resistance and castings for annealing, carbonizing, hardening and tempering. Estimated cost $250,000. J. A. Finegan, 276 Broad St., Newark, is architect.

N. J., Newark—Westinghouse Electric & Mfg. Co., 17 Academy St., awarded contract for the construction of a 2 story, 300 x 330 ft. factory at State Highway 25 and Haynes Ave. to Public Service Production Co., 80 Park Pl. Estimated cost $500,000.

N. J., Passaic — Continental Can Co., Inc., Brooks Ave., awarded contract for the construction of a 1 story, 50 x 110 ft. mill at Terhune Ave., to Mahony Troast Construction Co., 657 Main Ave. Estimated cost $40,000.

N. Y., Albany — Philfuel Co., Bartlesville, Okla., will build a plant including warehouse, pump house, storage shed and central heating plant, etc., at Schenectady Rd. stop 25, here. Estimated cost $70,000. Work will be done by owner's forces. L. Morant, Tulsa,, Okla., in charge.

N. Y., New York—R. Hoe & Co., 138th St. and East River, printing press manufacturers, awarded contract for a 3 story addition to plant at Walnut and 137th Sts., to Marshall Construction Co., 1767 Broadway. Estimated cost $125,000.

Pa., Willow Grove — J. S. Smith, Lackawanna and Womrath Sts., Philadelphia, will soon award contract for the construction of a 1 story, 58 x 128 ft. hosiery mill here. Estimated cost $40,000. W. P. Cameron Engineering Co., 4850 North Mascher, is engineer.

Tex., Abilene — Central Texas Iron Works, c/o O. Winchell, Waco, is receiving bids for the construction of a 3 story, 50 x 200 ft. steel plant here. Private plans. Steel mill equipment, including cutters, rollers, etc., will be purchased.

Ont., Mount Dennis—F. N. Burt & Co., 420 Wellington St. W., Toronto, will soon receive bids for the construction of a 1 story, 175 x 350 ft. stationery plant. Estimated cost $150,000. E. L. Sheppard, 57 Queen St. W., Toronto, is architect.

Ont., Toronto—Canadian Wheel & Rim Co., 27 Yorkville Ave., plans the construction of a 2 story, 54 x 166 ft. plant on Yorkville Ave. Estimated cost $80,000. Catto & Catto, 1 Wellington St. W., are architects.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

LOWER prices are quoted for January sales of conduit, elbows and couplings. Most of the other electrical supplies remain at December levels. In power plant supplies, the major change of the month was an advance of 1c. per lb., to 57c., in genuine, highest grade babbitt metal, delivered in case-lots from New York warehouse on orders of 100 lb. or over.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net)*60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%

	Air—Best grade			
¾-in., per ft	3-ply	$0.30	4 ply	$0.36

	Steam—Discounts from List		
First grade 40%	Second grade 45%	Third grade	50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-5%; 2nd grade, 45-5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.30 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.12½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.159	$0.164	$0.159

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	14.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ½-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	3.10

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, gronnd, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	57.00
Commercial genuine, intermediate grade	42.00
Anti-friction metal, general service	31.00
No. 4 babbitt	11.50

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.50	$3.65	$3.60
Flat or square	4.00	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mil lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	62%	50½%	1 and 1¼	31%	15%

LAP WELD

2	55%	43½%	2	23%	9%
2½ to 6	59%	47½%	2½ to 3½	28%	13%
7 and 8	56%	43½%	4 to 6	30%	17%
9 and 10	54%	41½%	7 and 8	29%	16%
11 and 12	53%	40½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60%	49½%	1 to 2	34%	18%
2 to 3	61%	50½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53%	42½%	2	29%	13%
2½ to 4	57%	46½%	2½ to 4	34%	20%
4½ to 6	56%	45½%	4½ to 6	33%	19%
7 and 8	52%	39½%	7 and 8	31%	17%
9 and 10	45%	32½%	9 to 12	21%	8%
11 and 12	44%	31½%			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mehanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3¼ to 4 in... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$33.85 (net)	$48.00 (net)	$180.00	$220.00
No. 12 solid....	136.00	180.00	225.00	275.00
No. 10 solid....	185.00	235.00	275.00	325.00
No. 8 stranded..	305.00	375.00	420.00	500.00
No. 6 stranded..	440.00	530.00	615.00	.....

From the above lists discounts are:	BX	Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft	60%	34%
1,000 to 5,000 ft	63%	36%
5,000 ft. and over	65%	48%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. No delivery charges, regardless of quantity.

Size Inches	Conduit Black Per M Ft.	Conduit White Per M Ft.	Elbows Black Per 100	Elbows Galvanized Per 100	Couplings Black Per 100	Couplings Galvanized Per 100
½-¾	$52.96	$57.80	$6.96	$8.05	$4.23	$4.63
¾	67.28	73.83	9.16	10.59	6.04	6.61
1	96.22	105.91	13.56	15.67	7.84	8.59
1¼	130.18	143.29	18.63	21.20	11.08	12.04
1½	155.65	171.33	24.84	28.26	13.68	14.88
2	209.42	230.51	45.54	51.81	18.24	19.84
2½	331.11	364.46	74.52	84.78	26.06	28.34
3	432.99	476.60	198.72	226.08	39.09	42.51
3½	546.94	599.38	438.84	499.26	52.12	56.68
4	668.72	730.85	507.15	576.98	65.15	70.85

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less Than $10 List	$10 List to $100	$100 List and Over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$21.50
No. 16 cotton reinforced heavy		25.00
No. 18 cotton reinforced light		15.50
No. 16 cotton reinforced light		22.00
No. 18 cotton Canvasite cord		17.00
No. 16 cotton Canvasite cord		27.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$70.80	*76.70
No. 14 super service cord or similar (2 wire) in 1,000 ft.	106.20	*115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500), per 100	$2.80
0-30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100-130 Volt Watts	General Type	Price Each	200-260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	...	.....
60	A 21	.20	...	...	.....
100	A 23	.35	...	...	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.50	$8.90	$11.20	$19.00
12	9.90	11.40	14.00	25.00
10	13.50	15.40	18.50	33.50
8	19.90	22.50	25.00	47.50
6	.....	.....	36.00	.....
4	.....	.....	52.00	.....
2	.....	.....	72.00	.....
1	.....	.....	97.00	.....
0	.....	.....	119.00	.....
00	.....	.....	143.00	.....
000	.....	.....	176.00	.....
0000	.....	.....	215.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	⅛ In. or Pendant Cap Key	⅛ In. or Pendant Cap Keyless	⅛ In. or Pendant Cap Pull	⅜ In. Cap Key	⅜ In. Cap Keyless	⅜ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 31c. per lb.; in 100 lb. lots, 29c. per lb
Rubber tape, ¾ in., in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb
Wire solder, in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%